CANADIAN ELECTRONICS ENGINEERING

NOVEMBER 1960
A Maclean-Hunter Publication
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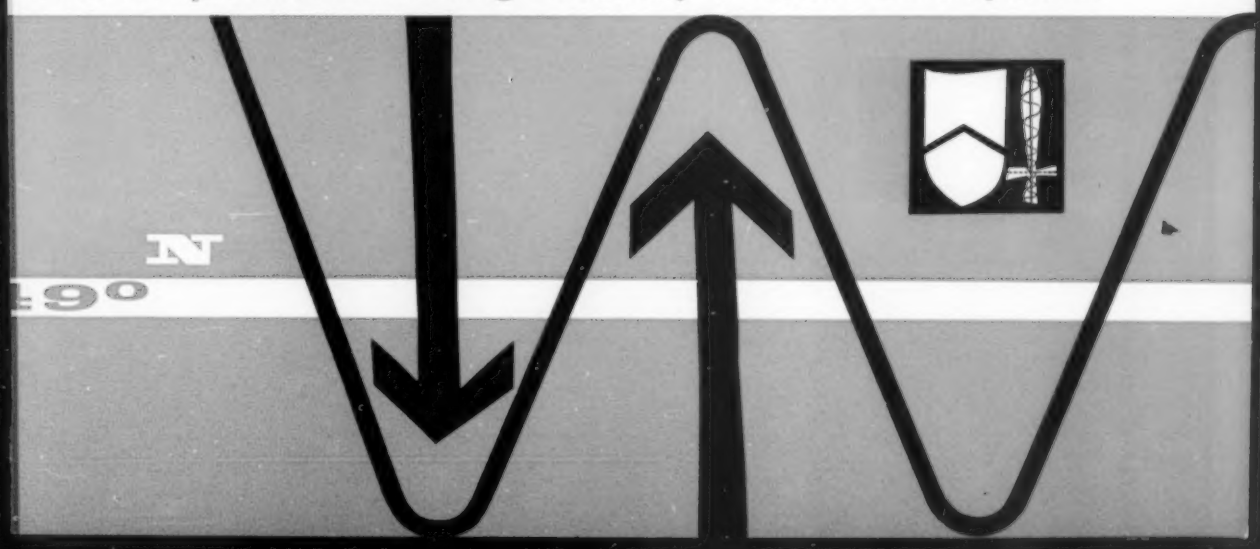
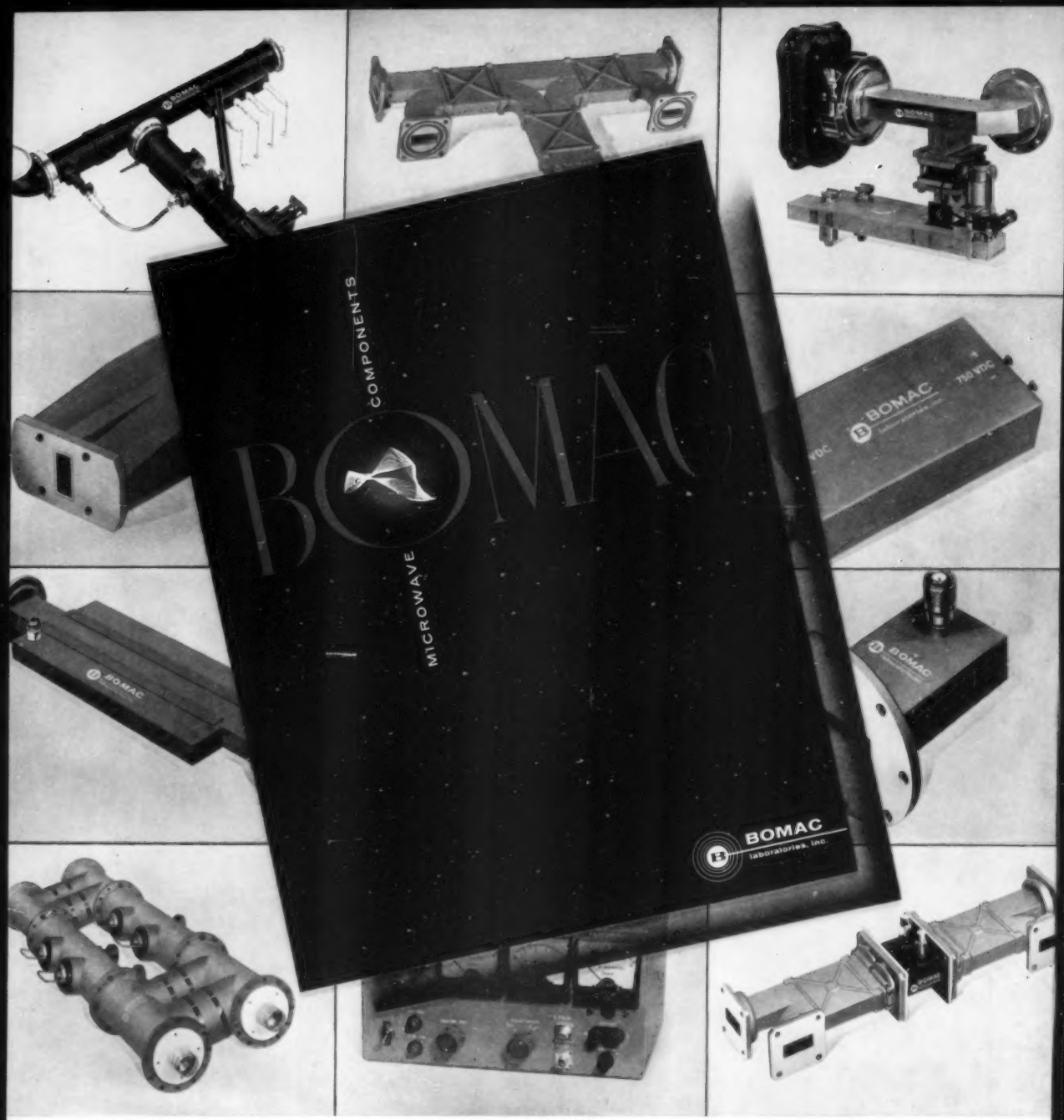
Simple power divider for microwaves is continuously variable

Apparatus for accurate temperature coefficient measurement

Graphical method permits checking vhf transistor stability

Defence production sharing—roundup of latest developments





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CANADIAN ELECTRONICS ENGINEERING

Volume four, number 11 November 1960

Defence Production Sharing

New reciprocal approval agreement for qualification of electronic parts

As of July 20, 1960, a new agreement for mutual recognition of qualification approval of military electronic parts exists between the appropriate agencies in the U. S. and Canada. The essential features of the agreement and how they affect Canadian firms are discussed.

A. P. Harris is a graduate in electrical engineering of McGill University. From 1944 to 1946 he was with the Department of Munitions and Supply, and the National Research Council. From 1947 to the present he has been with the RCAF and the Canadian Military Electronics Standards Agency (CAMESA), where he is responsible for the testing and approval of components and materials. He is a member of IES and APEO.

Production sharing requires different approach to technical publications

Production sharing contracts normally call for technical publications in accordance with U. S. specifications. This article discusses some of the differences between Canadian and U. S. specifications, then shows the need for a well-organized approach to publications.

J. F. (Ferd) Keay was born in Antigonish, N.S., and studied electrical engineering at St. Francis Xavier University and Nova Scotia Technical College. He served in the Canadian Army from 1950 to 1956 as the Signal Officer of an infantry company, and joined the technical writing firm of Cushing & Nevell Ltd. in 1958, where he has been mainly concerned with publications for military electronic equipment.

Electronic music at Stratford

Mr. Tanner attended a concert of electronic music which formed part of this year's Music Festival at Stratford, Ontario. He gives here his comments on the concert, and wishes to emphasize that these are his own personal opinions. Our editorial art director, Frank Davies, did the drawing which illustrates this article.

Robert H. Tanner received his BSc in engineering from the University of London (England) and came to Canada in 1947 after a number of years in the research department of the BBC and in the British Army. He has spent the last 13 years with the Northern Electric Company, and is now manager of Communication Systems Development in their R & D Labs. at Ottawa. He was awarded a Fellowship in IRE in 1958.

Simple power divider for microwaves is continuously variable

This continuously variable microwave power divider uses one fixed and one movable polystyrene strip as the dielectric to achieve phase shift. It has low insertion loss, low reflection of incident power, and high maximum value of attenuation.

A. Hendry was graduated from Queen's University, Kingston in 1952 with a BSc degree in engineering physics. After graduation he joined the Radio and Electrical Engineering Division of the National Research Council, Ottawa, where he has been engaged in the development of microwave radar receivers and associated equipment. Mr. Hendry is a member of the Institute of Radio Engineers.

continued on page 3

CONTENTS — continued from page 1

Simple apparatus measures temperature coefficient of components with high accuracy

A simple, accurate laboratory test apparatus has been developed for measuring the temperature coefficient of components to determine their suitability for use in stable tuning circuits. The theory is given for the frequency shift method used, then the equipment and its operation are fully described. Accuracies of 0.7 ppm/deg C can easily be achieved.

40

C. Rempel (1) was born in Winnipeg and joined the Signal Corps at the beginning of the war. He obtained his BA from University of Saskatchewan in 1950, and joined the Army Development Establishment, Electronic and Electrical Division (ADE) in 1952. He is a member of IRE. **H. Reiche** was born and educated in Berlin, graduating in 1936 in electrical engineering. Following electronic development work with other companies, he joined ADE in 1942, and has been in charge of the Components Group for the past seven years. Mr. Reiche is chairman of the Capacitor/Resistor Panel of the DRB Electronic Component Research and Development Committee, a senior member of IRE, and a member of APEO.

Graphical method permits checking vhf transistor stability

The range of loads, for which a quadripole is potentially unstable, is determined by a simple graphical construction after measurement of three driving point admittances. The theory is given and illustrated by application to four types of vhf transistor to find the maximum frequency at which each unit will oscillate by reason of its own internal feedback.

44

Malcolm A. Gullen (1) obtained an honours degree in physics from Edinburgh University. After service with the RAF, he studied electrical engineering at Purdue, and received his ME in 1951. Following service with the Army Development Establishment, he took an appointment at Carleton University, Ottawa, in the School of Engineering on July 1st of this year. Mr. Gullen is a member of the APEO. **H. Harry Schwartz,** a native of Ottawa, obtained his B.Eng. from McGill in 1958. He then worked on transistor circuit development at ADE until September 1959, when he returned to McGill for graduate studies in electrical engineering. Mr. Schwartz is an associate of the Institute of Radio Engineers.

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- add another person to an outside call
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Intercom telephones are another step forward in the science of communications by Northern Electric, who design and manufacture most of Canada's telephones and related equipment.

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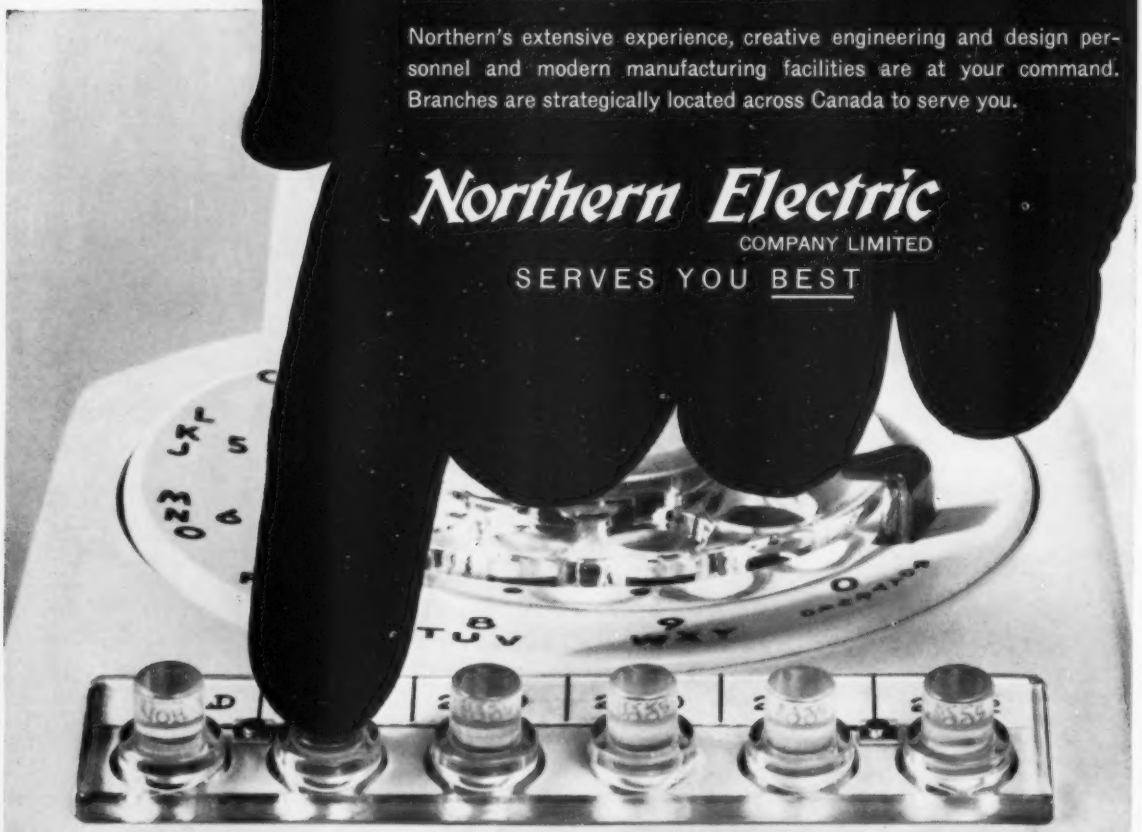


2060-4

NEWS HIGHLIGHTS

BBG decides "the time has not yet come for the introduction of color telecasting in Canada."

In a public announcement of September 30, the Board of Broadcast Governors gave notice that licenses will be recommended only for black and white television until color broadcasting and reception have received wider acceptance in the United States and nearby Canadian cities.

It also stated, in part: "Because of the changing techniques and the slow acceptance of color in the United States, the Canadian Department of Transport has not approved specifications for color telescasting, and television stations are not licensed to broadcast in color. The Board is not prepared at this time to recommend to D.O.T. that it approve specifications for color telecasting."

EIA comment

Speaking for the Electronic Industries Association of Canada, general manager Fred W. Radcliffe commented: "The recent decision of the Board of Broadcast Governors against recommending the licensing of color television is very disappointing to the electronics industry. The basing of the decision in part on a lack of viewer demand for color appears very short sighted and irrational in the industry's opinion.

"Most of the worthwhile advances in consumer products, which have added so much to Canadian productivity and increased employment, have arisen not after the public have demanded them but after the public have been shown, by the manufacturers' foresight, a better performing and more desirable product readily available.

"Had public demand been the basic reason for the release of high fidelity and stereophonic reproduction we would still be without it. Fortunately it did not have to be licensed to be released.

"Had we waited for the public to demand talking motion pictures we might still be fed a fare of silent movies.

"Had the oil burner industry waited for the public to demand their products most of us would still be shovelling coal and carrying out the ashes.

"Industry is constantly being urged to increase productivity. It is the recognized responsibility of secondary industry, which employs over 40% of the labor force (considering service industries related to production jobs), to use its development and productive processes to improve continuously all consumer products so that better performance, appearance, and value will expand consumer demand through exposure of new products and maintain employment at high levels.

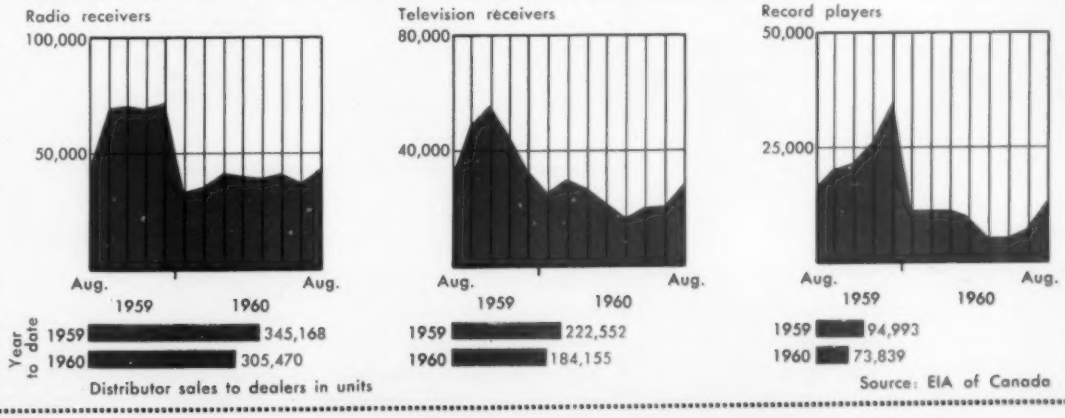
"Color television can only be exposed to the Canadian public by Canadian television stations being licensed to transmit it. Once Canadians generally have an opportunity to see for themselves how much better color television is, and given adequate programming and reasonably priced merchandise, then in our opinion they will demand it. But you do not ordinarily demand something which is unknown to you.

"Three hundred and sixty-seven of the 520 television stations in the U. S. A. are now equipped for network color, and nearly 25 percent are equipped to originate their own color programs in some form. Canadian stations should be similarly freed from present restrictions. Let the Canadian people see how much color will add to their television enjoyment and they will not be slow to ask that it be made available to them."

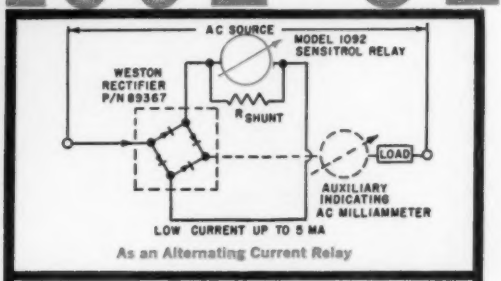
Japanese tube manufacturers place voluntary embargo on shipments of receiving tubes in Canada

See "Ottawa report" on page 9.

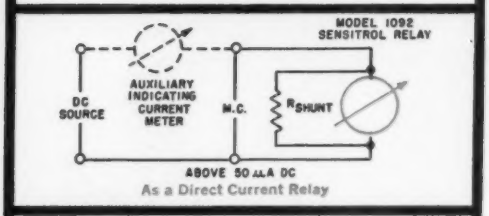
August sales of home entertainment products forge ahead



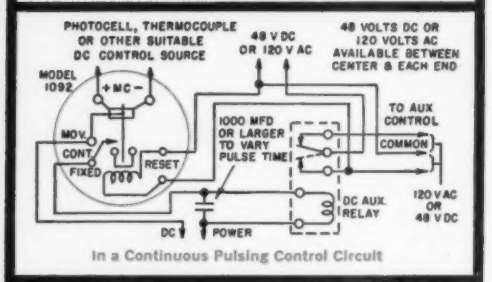
1092 SENSITROL®



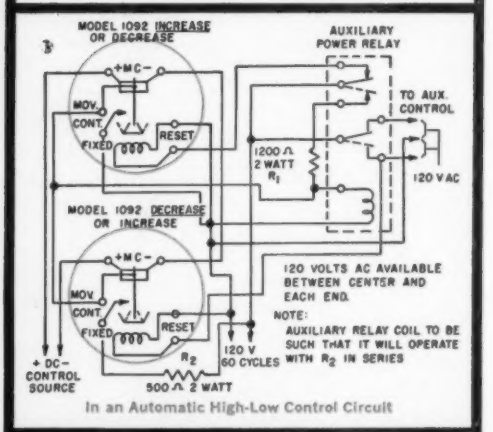
As an Alternating Current Relay



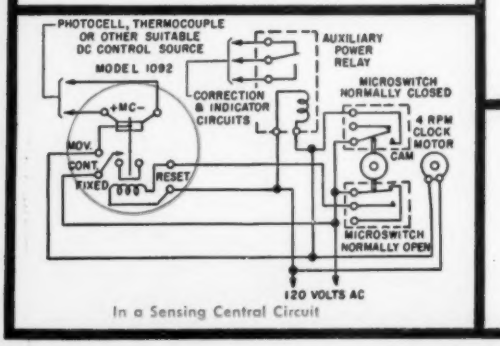
As a Direct Current Relay



In a Continuous Pulsing Control Circuit



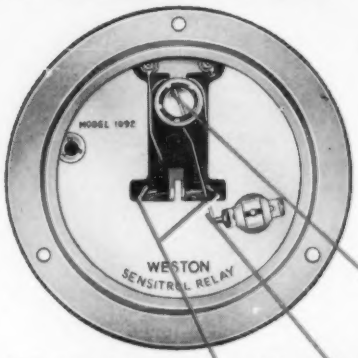
In an Automatic High-Low Control Circuit



In a Sensing Control Circuit

the versatile relay

LOOK AT THIS RANGE OF APPLICATIONS FOR WESTON'S FULLY-ADJUSTABLE, ULTRA-SENSITIVE RELAY. SENSITROL CAN SIMPLIFY YOUR ALARM OR CONTROL PROBLEM!



In breadboard circuits, the 1092 makes it unnecessary to pin-point electrical operating values through elaborate calculations or measurements. A single, moveable contact adjuster provides variable and accurately repeatable settings. In production equipment, the 1092 eliminates the need for stocking a variety of relays.

Model 1092's contain built-in reset mechanism and chatter proof locking magnetic contacts. They can be set to close at any value of D-C from 5 to 50 microamps, or a comparable millivolt span of 10 to 100 . . . and will handle 100 milliamps at 120 volts A-C or D-C.

For full information, write to Daystrom Limited, 1480 Dundas Highway E., Cooksville, Ont., or 5430 Ferrier St., Montreal, Que., a subsidiary of Daystrom Incorporated, or any office of Northern Electric Co. Ltd.

5929

WESTON *Relays*

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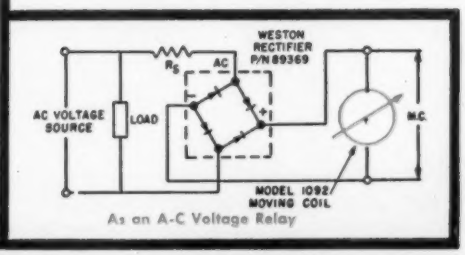


As an A-C Voltage Relay

For further information mark No. 26 on Readers' Service Card

Northern Electric Co. appoints six new vice-presidents

Peachey

Hunt

Fulton

Little

Wickes

Marquez

Six Northern Electric Co. Ltd. officials have been promoted to the rank of vice-president. **A. B. Hunt** becomes vice-president of research and development; **C. A. Peachey** becomes vice-president and general manager of the communications equipment division; **J. G. Little** becomes vice-president and general manager of the wire and cable division; **F. F. Fulton** becomes vice-president and general manager, telephone contract division; **V. O. Marquez** becomes vice-president and general manager, sales division; **S. B. Wickes** becomes vice-president and comptroller.

Secord joins Sperry Gyroscope Co. of Canada Ltd.

Allen H. Secord, formerly a project engineer with Sinclair Radio Labs., Toronto, has joined the development engineering department of Sperry Gyroscope Co. of Canada Ltd., Montreal. Mr. Secord graduated from the University of Toronto in engineering physics, and is a Member of the Institute of Radio Engineers. Until his departure from Toronto recently he was serving as chairman of the membership committee, Toronto Section, IRE.

Canadair appoints vice-president of engineering

E. H. Higgins has been appointed vice-president of engineering, succeeding **W. K. Ebel** who has been transferred to the Washington office of the parent General Dynamics Corp. Mr. Higgins, born in London, Ont., was educated at the University of Western Ontario and the University of Michigan. He has been with Canadair thirteen years.

Executive appointments at Canadian Aviation Electronics

C. D. Reekie, C.A., has been appointed project manager of simulators at Canadian Aviation Electronics Ltd., Montreal. Formerly comptroller and secretary, he will retain the office of secretary of the company.

G. G. James, C.A., has been appointed comptroller. He has been comptroller of the Western Division of the company in Winnipeg.

C.G.E. promotes Magnus in Tube Section

Canadian General Electric, Electronic Tube Section has appointed **Ross E. Magnus** manager of sales to equipment manufacturers. He will have direct responsibility for national sales of CGE tubes and capacitors to original equipment manufacturers in the entertainment, industrial and defence markets.

Magnus

Amyot

Amyot wins IRE Canadian Region student paper competition

With his paper, "Interference problems associated with automotive ignition systems," University of Ottawa student R. J. R. Amyot won the 1960 IRE Canadian Region student paper competition. He received a cash prize of $100 and his paper will be published in the IRE Student Quarterly.

Honorable mention went to Robert O'Kell of Ryerson Institute of Technology for a paper on "Special effects systems for television broadcasting."

Papers were judged by Dr. W. V. Tilson, Sinclair Radio Labs., Mr. A. E. Maine, The de Havilland Aircraft of Canada Ltd., and Mr. D. K. Ritchie, Ferranti-Packard Electric Ltd.

General manager of Wholesale Radio & Electronics Ltd.

George R. Gardiner, chairman of the Board of Directors, has announced the appointment of **W. F. Saynor** as general manager of Wholesale Radio & Electronics Ltd., a subsidiary of Zenith Electric Supply Ltd.

Saynor

Roth

Research and development manager

Canadian Aviation Electronics Ltd., has appointed **Sam Roth, B.Eng.,** as manager of the newly created Research and Development Department of the company. In this position he will direct the company's advanced and long term development engineering programs. Mr. Roth was formerly a section chief in the research and development department of Canadair Ltd., with responsibility for all electronic research, test and development in the Aircraft Division. He has also served with the National Research Council in the Radio and Electrical Engineering Division.

AMA appoints new members to Planning Council

One of the four new members appointed to the Planning Council of the American Management Association's Research and Development Division, is **R. D. Harkness,** president of Northern Electric Co. Ltd., Montreal. The planning council consists of 24 executives who serve AMA on a voluntary basis by providing advice and counsel to the association in the planning of meetings held by the division.

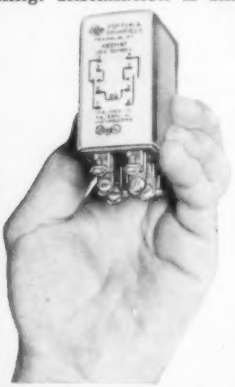
Bolton joins Philco's publications group

James Bolton has joined the Technical Publications Department of Philco Corporation of Canada Ltd. He was, until recently, general supervisor of publications, Electronic Associates Ltd.

appearances are not deceiving

THIS P&B 10-AMP RELAY IS AS RELIABLE AS IT LOOKS

Our AB relay looks rugged . . . and it is. You can specify it for 10 amp switching and confidently expect 100,000 cycles. Yet it is compact, easily mounted, and does not require special handling. Installation is simple, using your preference of screw terminals (adapters), quick connects, or dip soldering.



ABC Series—AB series can be supplied enclosed in sturdy metal dust cover, 1 31/64" x 2 25/32" x 2 13/32".

Designers specify the AB for air conditioners and other products where dependable, continual service is paramount.

These standard AB and ABC relays are listed by Underwriters' Laboratories and Canadian Standards Association:

Type	Arrangements	Type	Arrangements
AB7AY	DPST-NO	ABC7AY	DPST-NO
AB8AY	DPST-NC	ABC8AY	DPST-NC
AB11AY	DPDT	ABC11AY	DPDT

Coil voltages: 6, 12, 24, 115 and 230 volts AC, 50/60 cycle.
Contact rating 10 amps. 115 volts AC or 5 amps. 230 volts AC noninductive.

U/L File E-29244 CSA No. 15734

Write for complete data or contact your nearest P&B sales engineer.

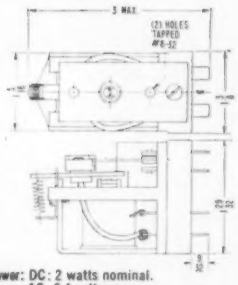
AB AND ABC RELAYS ENGINEERING DATA

GENERAL:
Insulation Resistance: 100 megohms minimum.
Life: 3 million cycles (mechanical).
Breakdown Voltage: 1500 volts rms between all elements and ground.
Temperature Range: DC: −55 to +45°C.
AC: −55 to +45°C.

Weight: AB—5 ozs. ABC—7 ozs.
Terminals: Fit ¼" quick-connect terminals, or may be applied to printed circuits using dip soldering. Screw adapters furnished on request.
Enclosure: ABC: Heavy duty dust cover.
Dimensions: 1 31/64" x 2 25/32" x 2 13/32".

CONTACTS:
Arrangements: DPDT
Material: ¼" dia. silver. Other materials available.
Load: 5 amps at 230 volts AC or 10 amps at 115 volts AC noninductive.
10 amps at 28 volts DC.

COIL:
Voltage: DC: 6 to 110 volts.
AC: 6 to 230 volts.



Power: DC: 2 watts nominal.
AC: 6.4 volt-amps.
Resistance: 35,000 ohms max.
Duty: Continuous: DC coils will withstand 6 watts at +25°C.

MOUNTINGS:
AB: Two 8-32 tapped holes on 1¼" centers.
ABC: One 8-32 stud ⅛" long and locating tab.

P & B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD CANADA LTD.

GUELPH, ONTARIO

For further information mark No. 44 on Readers' Service Card

Philips Electronics sells $140,000 ionospheric sounder to U.S. Army

The United States Army Signal Corps has purchased a Canadian-made oblique ionospheric sounder from Philips Electronics Industries Ltd., Toronto. Valued at $140,000, the equipment will be mounted into trucks for use at various locations by personnel of the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J.

The Oblique Sounder, by measuring the propagation conditions in parallel with a communication circuit, can provide a measure of propagation conditions in the immediate future and make more reliable communications possible. The equipment was originally developed under the direction of the Canadian Government Defence Research Telecommunications Establishment, who have had several links in successful operation for some time.

F. H. Dickson (centre), director of U. S. Army Radio Propagation Agency, and H. L. Kitts (right), project manager of U. S. Army Signal R & D Laboratory, inspect the Oblique Sounder in its final stage of manufacture, while Fred Daniels, section head in Philips' Professional Equipment Division, explains some of the technical aspects.

Changes in technical standards for land mobile vhf systems

DOT has announced that, effective September 1, 1960, a change has been made in the technical requirements for licensing of new land mobile radiotelephone systems operating in the vhf 152-174 Mc band within the densely populated areas of southern Ontario and Quebec, extending from Sault Ste. Marie eastward to include Quebec City, and in southwestern British Columbia extending approximately from Hedley westward.

After that date, new vhf systems in those areas within 75 miles of the Canada/U. S. border must be capable of operation on frequency channels spaced 30 kc apart, as compared with the spacing of 60 kc, which continues to apply in other areas for the present.

The closer channel spacing has been made possible by DOT radio standards specifications and the subsequent production of radio equipment meeting those standards. Full advantage will be taken of additional channels made available for assignment to new land mobile vhf systems, which so far could not be licensed because of frequency congestion in the areas concerned.

Paisley winner at EIA-IRE golf tournament

Nearly 100 golfers met September 29 for the annual tournament at Scarborough, Ont., organized jointly by the Electronic Industries Association of Canada and the Institute of Radio Engineers. They were joined by a similar number of non-players in the evening for a buffet dinner and the presentation of trophies.

The IRE Low Gross Trophy was won by Peter Paisley, Capacitors of Canada, with an 83; the EIA Low Gross Wrigley Trophy was taken by Ross Gillis, Collins Radio, with a 75. The Diamond State Trophy for the tournament Low Net was won by J. Callan, Cannon Electric (56), and the Weston Wrigley Team Trophy for the best 36-hole net score by two players from one company was won by A. P. H. Barclay and F. H. R. Pounsett, Philips Electronics Industries.

A new trophy was added this year for the permanent possession of the winner annually—the Lake Engineering Trophy, presented by Lake Engrg. Co. Ltd. for the Second Low Tournament Net. It was won this year by A. L. Stopps of El-Met Parts with a score of 58. The Second Low Tournament Gross prize was taken by R. P. Scott of C. C. Meredith with a 77.

Pullmax opens Canadian factory branch

A new factory branch, Pullmax (Canada) Ltd., has been established at Oakville, Ont. to sell and service the Pullmax patented metal-working machine made by A. B. Svetsmekano of Goteberg, Sweden. Address is: South Service Rd., P.O. Box 460.

Canada Wire to make telephone cable at Lancaster, N.B.

The initiation of the manufacture of plastic insulated telephone cables in the Atlantic Provinces is announced by Mr. O. W. Titus, president, Canada Wire and Cable Co. Ltd.

This will be the result of an immediate substantial enlargement of the present Western Wire and Cable Co. plant at Lancaster, N.B., which will now become known as Canada Wire and Cable Co. Ltd., Atlantic Division.

Mr. M. C. Schofield, P.Eng., a native of New Brunswick, formerly superintendent of the Western Wire and Cable plant, is appointed plant manager.

(Continued on page 54)

Ottawa report

Imports of Japanese electronic tubes have been stopped for the rest of this year and will resume in 1961 subject to agreed quotas.

Final figures for imports of radio and television receiving tubes this year are not available but reports here indicate they will be in the region of 3,500,000. Imports for the first seven months of 1960 were 2,589,000, twice those of the same period last year and well ahead of the 1959 total of 2,324,000.

Noteworthy aspect of the announcement by Finance Minister Fleming was the speed with which it was made.

Official protests by the Electronic Industries Association were made to the government in a brief presented in mid-July.

Action by the Finance Department to reach acceptable quotas was taken immediately through negotiations with Japanese officials. In addition, the Revenue Department carried out a survey of valuations for duty purposes on the imported tubes. The survey is completed but no action has yet been taken.

The wire from Tokyo approving the cessation of shipments of tubes arrived in Ottawa on October 20 and was made public on the morning of Fri., Oct. 21, three months after the presentation of the brief by the industry.

This speed contrasts with the

(Continued on page 54)

GM 6025

μV

mV

V

Electronic

Internal calibration

It should be noted that all Philips electronic voltmeters contain calibration standards which enable the user easily and rapidly to check, and, if necessary, to re-calibrate his voltmeter at any time without the use of additional instruments.

PHILIPS *electronic measuring*

Sold and serviced by Philips Organizations all over the world

Further information will gladly be supplied by:

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116 Vanderhoof Ave., Toronto 17, Ont.
8525 Decarie Blvd., Montreal.

VHF Voltmeter, type GM 6025

frequency range up to 800 Mc/s

sensitivity 10mV f.s.d.

Frequency range
0.1 Mc/s - 800 Mc/s flat from 1 Mc/s - 300 Mc/s *(see graph below)*
- 1dB at 0.1 Mc/s
+ 1dB at 800 Mc/s

Measuring range
10 mV (f.s.d.) - 10 V divided into 7 ranges in a 1-3-10 sequence.

Accuracy
The overall accuracy is better than 5% with respect to full scale.

Input impedance
Input capacitance: 1 $\mu\mu$F
Input resistance at: 1 Mc/s 65 kΩ
100 Mc/s 50 kΩ
200 Mc/s 35 kΩ

Linear scale
Due to voltage-dependent feed-back the scale is linear. It is calibrated directly in the r.m.s. value of the VHF voltage and has an effective length of 5".

Calibration voltages
The front panel contains a calibration socket which for any setting of the range selector provides the appropriate calibration voltage for that range.

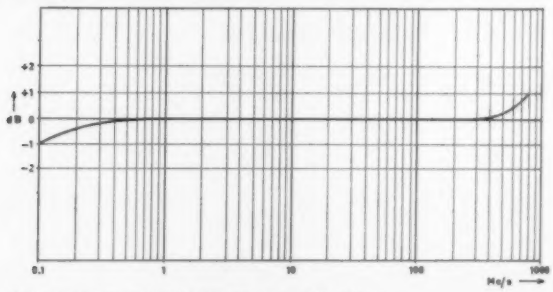
Replacement of the probe crystal
The probe crystal can be easily replaced and the instrument rapidly re-calibrated by the user.

Coaxial T-connector
For measurements on 50Ω-coaxial lines the T-connector, type GM 6050T can be ordered separately.

GM 6012 2 c/s - 1 Mc/s, 1 mV (f.s.d.) - 300 V

GM 6014 1 kc/s - 30 Mc/s, 1 mV (f.s.d.) - 30 V

millivoltmeters



Response curve with T-connector, type GM 6050 T

GM 6020 D.C. 100 μV (f.s.d.) - 1000 V

instruments: **quality *tools* for industry and research**

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One more point. The problems inherent in machining polyester glass laminates have had a tendency to discourage some designers from considering it. We suggest that you bounce this headache out of your production facilities and into ours.

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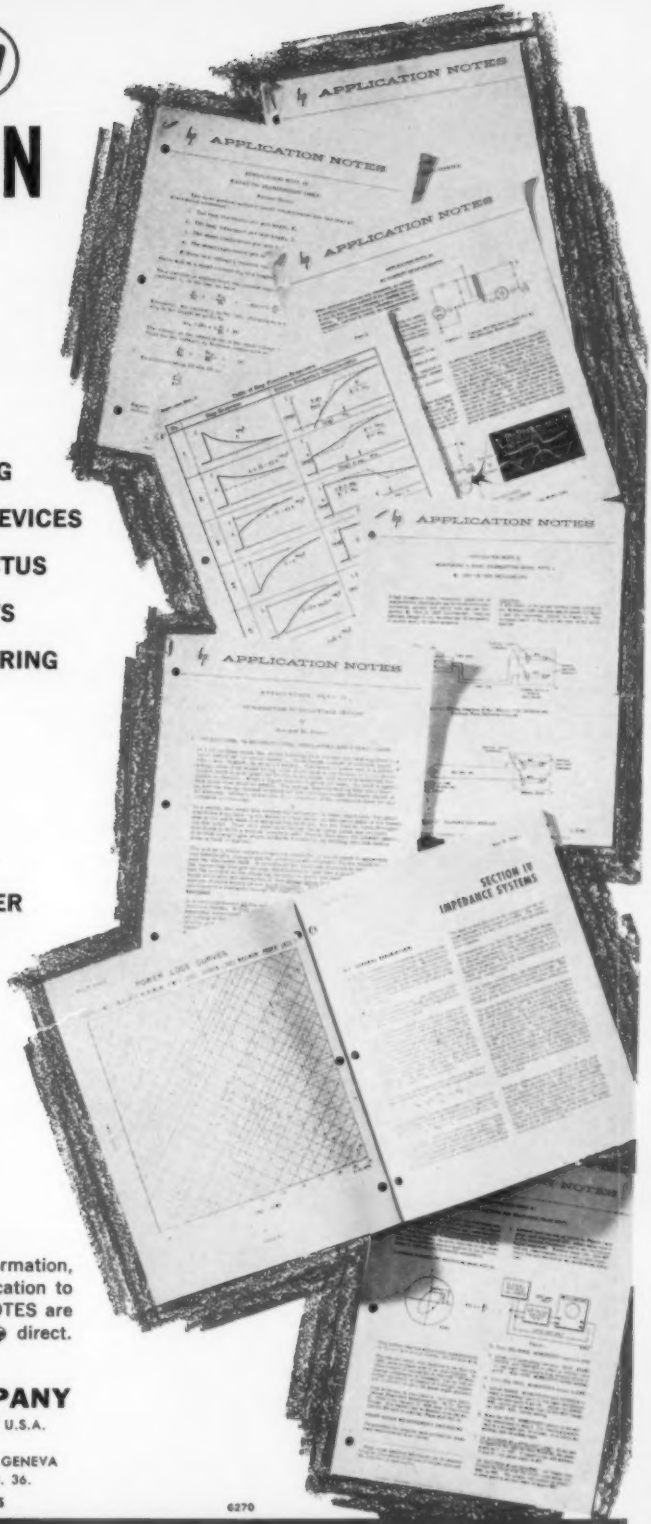

#16 WAVES ON TRANSMISSION LINES

#17 SQUARE WAVE AND PULSE TESTING

#18 INTRODUCTION TO SOLID STATE DEVICES

#21 MICROWAVE STANDARDS PROSPECTUS

#27 BASIC MICROWAVE MEASUREMENTS

#29 CONVENIENT METHOD FOR MEASURING PHASE SHIFT

#30 MEASUREMENT OF CABLE CHARACTERISTICS

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#38 MICROWAVE MEASUREMENTS FOR CALIBRATION LABORATORIES

#39 STANDARDS CALIBRATION PROCEDURES

#40 HEWLETT-PACKARD ELECTRONICS INSTRUMENTATION FOR TRANSDUCER APPLICATIONS

The above involve both theoretical and "how to do it" information, illustrated, complete, designed for swift practical application to your problem. These and all other hp APPLICATION NOTES are available by calling your hp representative, or writing hp direct. No charge, no obligation.

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Heinemann's new Series VP circuit breaker can give you elbow room to work with in engineering compact equipment. Just 2½" x ⅝" x 2¼" overall, it tips the scales at a piddling 1½ ounces, and requires only a half-inch of panel space (without the ON-OFF plate). Yet, small as it is, it can double in brass. The standard series-trip model, for example, can serve you as a toggle switch as well as overload protector. Other models with special internal circuit constructions (shunt-trip, relay-trip, calibrating-tap, auxiliary contacts) can do even more to simplify a schematic, eliminate components. □ Like all Heinemann circuit breakers, the VP breaker is magnetically actuated, has a hydraulically controlled, inverse time delay. Completely non-thermal, it doesn't have to be de-rated for high ambient temperatures. □ You can have this breaker in any integral or fractional current rating from 0.050 to 15 amps, for 110 V, 60 or 400 cycles AC, or 50 V DC. Our new Bulletin VP will give you more information. Drop us a line, and a copy's yours.

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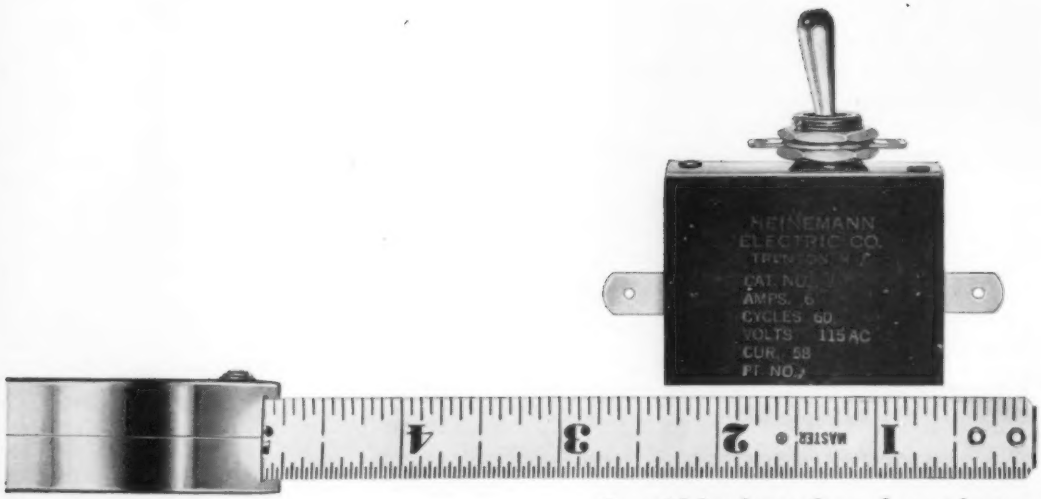

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SA 2316

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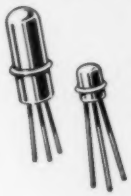
Even in high-frequency and rapid-switching types...



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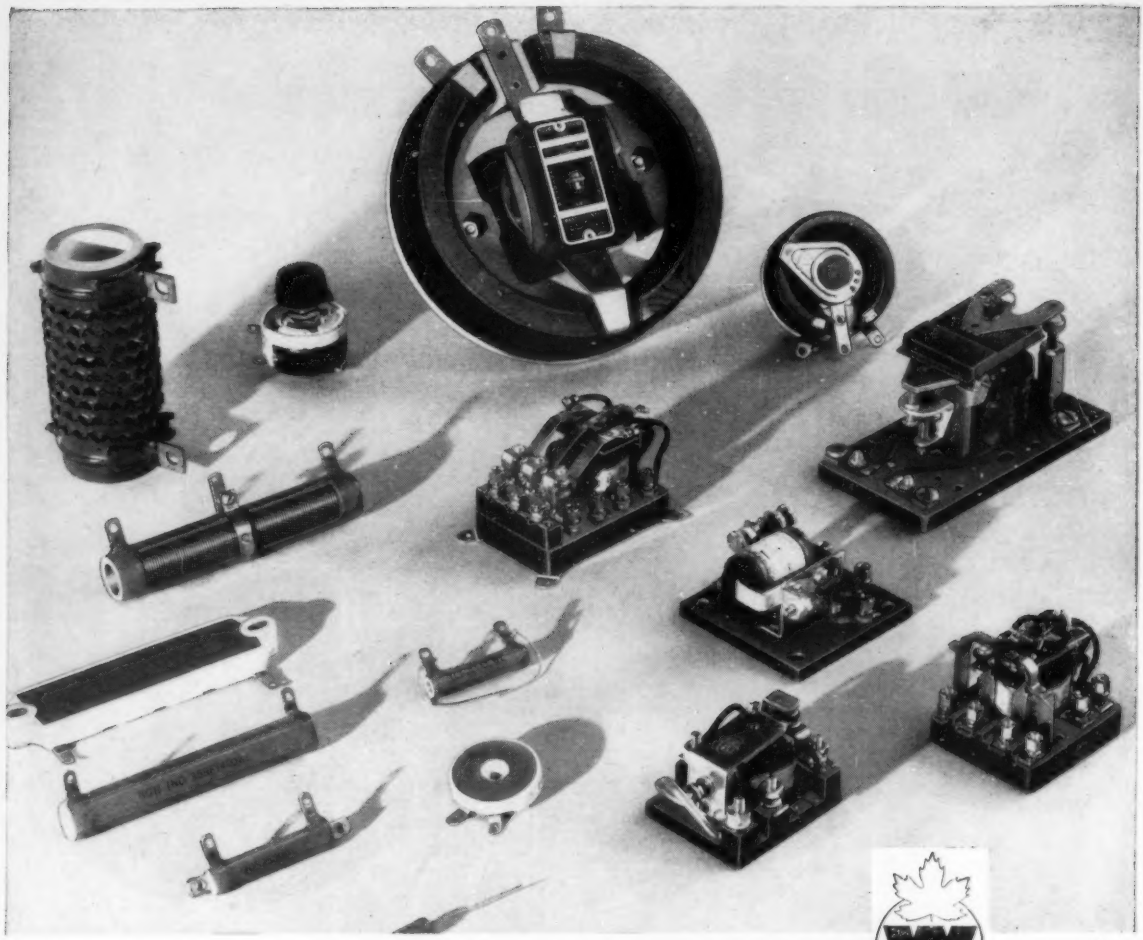

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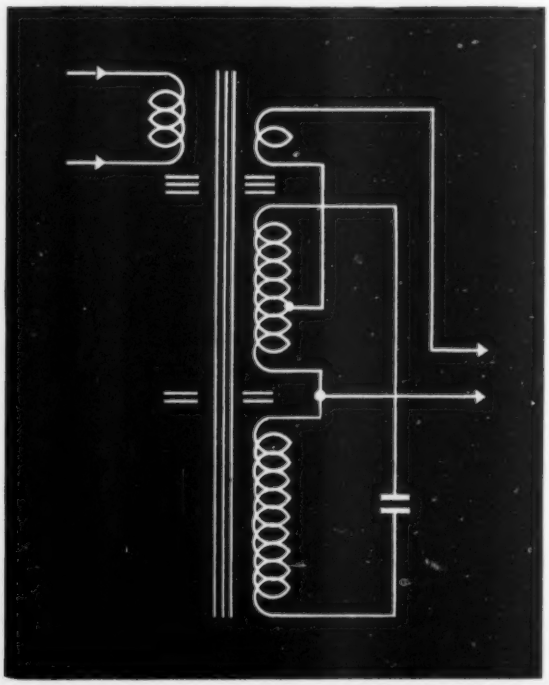
Phantom view shows simplicity of Sola design. Note absence of components requiring maintenance such as motors, gears, contactors, tubes and relays.

Schematic diagram indicates the complete reliance on static elements. This is the circuit of a representative Type CVS regulator which delivers output having less than 3% total rms harmonic content.



What's missing in this Sola voltage regulator?

When they designed the Sola Constant Voltage Transformer, what did they leave out? Trouble, for one thing. Original equipment manufacturers and plant engineers know that when you build in simplicity, you build out maintenance headaches.

The two illustrations at the left show clearly the Sola's few parts and straightforward design. This compact simplicity is possible because Sola regulators employ static-magnetic methods of voltage control.

The basic Sola design eliminates moving parts, renewable parts, manual adjustments, routine maintenance, and spare parts stock. Because there is nothing to wear out, no tubes to burn out — you know that when you specify Sola voltage stabilization, you automatically specify trouble-free reliability.

Despite this simplification, the Sola gives you these performance benefits: ±1% regulation over input voltage variations as great as ±15%, response time of 1.5 cycles or less, protection against short circuits for itself and its load, a high degree of isolation between input and output circuits, and negligible external field. Type CVS (illustrated with typical circuit diagram) delivers a commercial sine wave with less than 3% total rms harmonic content.

Sola static-magnetic units are available for regulation of common line voltages, as well as filament, plate-filament, computer-circuit and variable voltage outputs. They can also be supplied in step-up and step-down ratios to replace conventional non-regulating transformers.

Whether you are developing new electric or electronic equipment, or have a specific voltage regulation problem, your nearest Sola sales engineer will be happy to discuss your requirements with you.

Write for Bulletin CV

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2 NEW
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HIGH ADAPTABILITY TO YOUR NEEDS . . . AT LOW COST

Basically indicators, the Type 560 and Type 561 Oscilloscopes accept a wide range of plug-in units in both channels and permit almost any type and degree of performance demanded for a particular application. They feature plug-in units which drive the crt deflection plates directly—therefore, they are not limited by the additional circuitry that other oscilloscopes impose (between the plug-ins and deflection plates). Fewer components and controls simplify operation. And, with approximately two-thirds of the circuitry housed within the plug-ins, servicing is easier and indicator unit "down time" is less.

You can even design your own circuitry into skeleton units available. Or, if you are faced with a measurement problem in the dc to 4 mc region, one not solved adequately by existing Tektronix plug-in combinations, your Field Engineer would like to hear from you.

TYPE 560 INDICATOR . . . $325

5-inch monoaccelerator cathode-ray tube.
3.5-kilovolts accelerating potential.
8 by 10 centimeter viewing area.
Z-axis input.
2 calibrator square-wave voltages, at line frequency (for time-base calibration).
12-volt dc regulated heater supply (for gain stability, low hum, and low drift).

Regulated dc supply operates between 105 to 125 volts or 210 to 250 volts, 50 to 800 cycles . . . *provides 30 watts for powering the following signal-amplifier and time-base plug-in units:*

TYPE 50 . . . . . $115
Passband—15 cps to 200 kc.
Sensitivity—1 mv/cm.

TYPE 51 TIME-BASE UNIT $135
Sweep rate—5 ms/cm, calibrated.
Magnifier—Variable, uncalibrated, from 1X to 20X.
Triggering—Automatic or free-run.

TYPE 59 UNIT $50
Passband—dc to 400 kc, at maximum sensitivity.
Sensitivity—approximately 1 v/cm, attenuation provided by variable potentiometer at the input.
Maximum Input Voltage—600 volts.

TYPE 60 UNIT $100
Passband—dc to 1 mc.
Sensitivity—50 mv/cm to 50 v/cm, calibrated decade-step attenuator (4 steps), with variable control.

TYPE 63 DIFFERENTIAL UNIT . . . $125
Differential input, 100-to-1 rejection ratio at maximum sensitivity.
Passband—dc to 300 kc.
Sensitivity—1 mv/cm to 20 v/cm in 14 calibrated steps, with variable control.

TYPE 67 TIME-BASE UNIT $150
Sweep rates—21 calibrated steps from 1 μsec/cm to 5 sec/cm, accurate within 3%.
Magnifier—5X.
Triggering—Amplitude-level selection, automatic, or free-run, ac-coupled or dc-coupled, rising or falling slope, internal source, external source, or line frequency.
External Input to Sweep Amplifier—1 v/cm sensitivity.

TYPE 561 INDICATOR . . . $425

5-inch monoaccelerator cathode-ray tube.
3.5 kilovolts accelerating potential.
8 by 10 centimeter viewing area.
Z-axis input.
18 calibrated square-wave voltages, approximately 2 μsec risetime, at line frequency (for time-base calibration).
Regulated dc heater voltage thru separate regulator circuitry.

Regulated dc supply operates between 105 to 125 volts or 210 to 250 volts, 50 to 800 cycles . . . *provides 90 watts for powering all future and present plug-in units in this series—including those six already mentioned: Types 50, 51, 59, 60, 63, 67, plus the following two:*

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Identical Channels—5 operating modes: alternate sweeps, chopped, Channel A only (may be inverted), Channel B only, both channels combined at output (B ± A).
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Sensitivity—10 mv/cm to 20 v/cm in 11 calibrated steps, with variable control.

TYPE 75 WIDE-BAND UNIT $175
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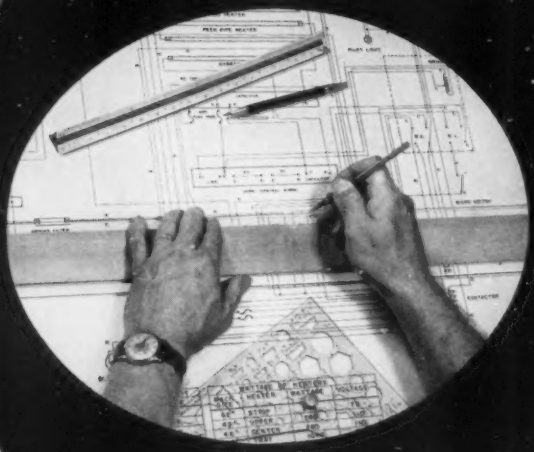

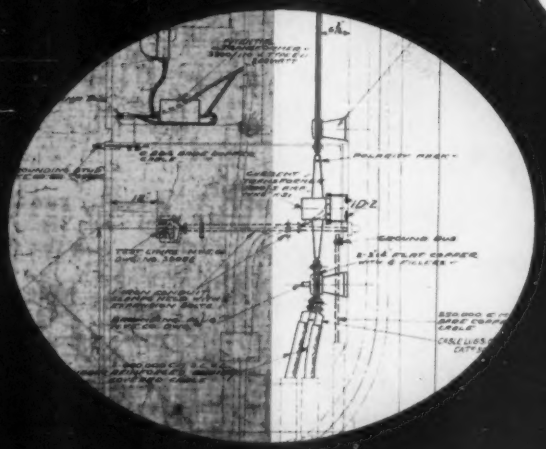

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ELECTRONICS—
INDUSTRY'S TOOL OF THE FUTURE

a December feature report by Canadian Electronics Engineering

"What's ahead for electronics in Canadian industry?" . . . "What are the problems in selling new techniques?" . . . "What are the economic factors faced by the user?"

These and many more pertinent questions arise daily in top management circles as new developments appear in the growing field of industrial electronics.

In its December issue, Canadian Electronics Engineering will attempt to answer these questions. Authoritative, well-illustrated articles written by leaders in Canadian industry will review available knowledge, report on most recent developments and peer into the future. Mr. Eric Leaver, president of Electronic Associates Limited and a director of the American Management Association, will write the keynote article.

Among the subjects covered will be: economic factors involved —technical training—management's approach to assessment and procurement—the relationship between electronic, hydraulic, pneumatic and other control systems—and developments in industrial control systems.

Here's how this will help advertisers. Everybody is interested in the future. This means that CEE's December issue featuring "Electronics—Industry's Tool of the Future" will be read with more than usual interest. Extra reader interest means high readership of the advertising pages—more opportunities to sell your products. Plan now to take advantage of this excellent advertising opportunity. Reserve extra space in CEE's December issue.

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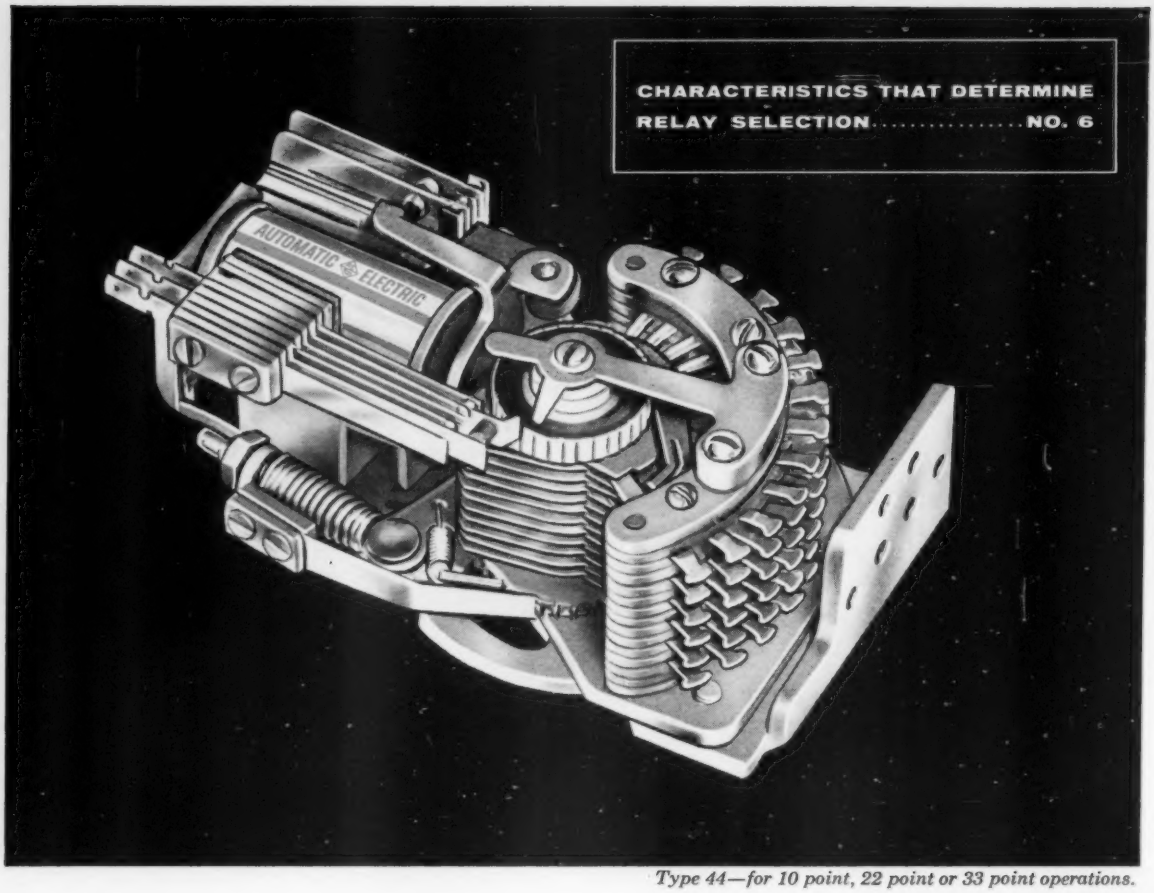

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Up to six 10-point bank levels
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OPERATING LIFE
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The Type 44 rotary stepping switch by Automatic Electric, is not much bigger than a pack of cigarettes, yet it can accommodate up to six 10-point bank levels. It can be used for almost any d.c. switching operation . . . for fast and reliable impulse-controlled response . . . or for completely trouble-free self-interrupted operation. And because it is extremely light for its capacity, it simplifies not only equipment design, but space and weight problems—over a wide range of applications—as well. The ten bank levels have corresponding wiper levels, and by proper arrangement of the wipers the switch can be used for 10 point, 22 point, or 33 point operation. Cost is reduced by the one-coil design which eliminates a separate release coil, and the switch has an average life of 200 million steps—or more.

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Defence Production Sharing

More news would spur industry's efforts

In August of last year, we presented a report on the Canada-United States Defence Production Sharing Program, including a survey of the capabilities of Canadian electronics and allied manufacturers. This month we feature a round-up of the latest developments in this area.

Mr. D. A. Golden, Deputy Minister of Defense Production, Ottawa, has contributed a progress report on the program. He stresses the growing importance of development sharing and component source development, and outlines DDP's views on what is required of Canadian industry.

This is followed by a review of the highlights of a brochure about the program that DDP has recently published. It covers the latest agreements on Buy American Act exemptions, duty-free entry, etc. The important question of reciprocal qualification approval for component parts and materials is dealt with by Mr. A. P. Harris of CAMESA, and Mr. J. F. Keay of Cushing & Nevell Ltd. has contributed an article on the preparation of technical publications on production sharing contracts.

We understand that there have been some instances of Canadian companies failing to even acknowledge receipt of invitations to submit tenders or proposals. This kind of negligence can affect the reputation of Canadian suppliers as a whole. We were therefore pleased to see the following warning included in the DDP brochure: "You must respond in some manner to all IFB's, RFP's and RFQ's. The service can remove your name from its bidders' mailing list on your first failure to reply, and will certainly do so the second time."

On the other hand, we believe the great contribution that DDP is making to the success of the Production Sharing Program could be improved in one respect. Mr. Golden says in his article: "Many Canadian companies in the electronics field have exerted real efforts to participate in U. S. contracts and **some have been successful."** Is it not possible to release the details of some, if not all, of these successes?

We are sure that news of concrete examples of the kind of business that is being brought into Canada would lead to greater efforts by other manufacturers. And, naturally, the technical press would be only too pleased to co-operate in bringing this news to its readers in the Canadian electronics industry.

THE EDITOR

Production sharing and Canadian defence electronics

D. A. Golden, *Deputy Minister,*
Department of Defence Production, Ottawa.

The primary purpose of the Canada-U. S. Defence Production Sharing program is to provide greater opportunities for Canadian industry to compete for defence business in the United States. The key words here are "opportunity" and "competition". All that government officials can do is to ensure that the opportunities are afforded to industry; the competing for these opportunities can only be done by industry itself.

As my minister pointed out in the House of Commons when the estimates of the Department of Defence Production were being considered, the U. S. authorities have made and are making an honest attempt to create conditions which will permit Canadian industry to compete fairly in the U. S. for some U. S. defence business. Not all areas have been opened up, but very wide ones have. The Buy American Act provisions have been waived. Duty free certificates may be obtained. Security clearances are being expedited.

Many Canadian companies in the electronics field have exerted real efforts to participate in U. S. contracts and some have been successful. A concentrated effort is required, confined to those areas where a company knows it has genuine competence and is likely to be competitive as far as price and delivery are concerned.

Development sharing

At the start of the production sharing program emphasis was placed upon Canadian participation in production. It soon became obvious that in the long run it was essential that our industry become involved at an earlier stage of equipment programs and that, in effect, production sharing must start in the development phase or earlier. Only in this way can Canadian industry enjoy real equality of opportunity with American firms in relation to American programs. As a result, increasing emphasis has been devoted to the development aspect of the production sharing program.

In pursuing this goal, we have found it necessary to adopt a variety of approaches. Initially the main emphasis has been on the ad hoc problems of locating specific U. S. military requirements in those areas where existing Canadian capabilities are not fully employed. Over the longer term, there will be three main aspects of the development sharing program:

1. Formal U. S. development requirements, funded in the U. S., for which Canadian industry competes with U. S. industry. Canadian companies have bid in a number of cases, but this is a very difficult area to break into and we have not yet had any significant prime contract successes in the electronics field. There is evidence, however, that both prime and sub-contracts of a study or research nature may be obtained by a relatively modest effort on the part of the contractor.

2. Original Canadian concepts, financed by Canada, but whose successful development would be of confirmed interest to the U. S. military. Under this heading support is being given to a number of Canadian companies, some of them in the electronics industry, and we are hopeful that production orders will result in at least some instances.

3. Formal U. S. development requirements which, by mutual agreement, are financed by Canada using Canadian facilities and capabilities. Under this heading, much effort has been devoted to reaching agreement with the U. S. government on such matters as ownership and use of proprietary rights, responsibility for project monitorship, availability of specifications and classified documents, security clearances, and the like. Several projects concerned with electronics items are currently being investigated by this department.

While it is recognized that the number of active development sharing contracts is limited to date, this is not really surprising as our real efforts started only about a year ago and the process of originating applied research and development activities is a time-consuming operation. This is, in fact, the chief limiting factor in our current efforts. Funds are available—Parliament voted $5 million for the support of these development projects in 1959/60, of which only a fraction was spent, and in the current year

a like amount has been made available. Our immediate problem is to direct the available funds into the most promising channels. It is expected that the number of contracts will increase considerably during the next year of operation.

Component source development

In addition to our production sharing program—and to some extent related to it—we have another program designed to foster the expansion and improvement of Canada's industrial skills, especially in the electronics industry. This is known as the component source development program.

It has long been recognized by the Department of Defence Production that the parts manufacturers in the electronics industry have a unique significance. Without in any way wishing to belittle the importance of the design, engineering and production of sophisticated end-items, we must attach great importance to the work of those specialists who conceive and produce the multitude of essential bits and pieces on which the equipment manufacturers depend—and on which the performance of the end-items depends. Moreover, the standards imposed on the component manufacturers by modern military requirements are extremely stringent—and becoming increasingly so, day by day, as electronic equipment grows in complexity. Production to such standards cannot be developed at short notice, when equipment orders are placed. This means, obviously, that if the Canadian electronics industry is to include a vigorous sector devoted to this very basic activity, component requirements must be anticipated, and qualified sources must be established in advance of probable needs. By "qualified" I mean a source of supply which is acceptable to both the Canadian and the United States military—hence the relevance of the component source program to production sharing.

Two years ago, the Department of Defence Production assumed full responsibility for the development of component sources in Canada, and Parliament has provided us with funds in both 1959/60 and the current year. I can report that, to date, we have completed six projects with electronics parts manufacturers, eleven others have been approved and are under way, and we have plans for a greater number in the immediate future.

I have dealt with those things which the Government, through my Department, is doing to maintain and strengthen the Canadian electronics industry. In part, this is a matter of material support — through tooling and preproduction assistance, the financing of development projects, component source development and, of course, the use of Canadian facilities, wherever possible, to meet the equipment needs of the Canadian Forces. In addition, through the production sharing programme, we are trying to open up large new opportunities in the United States — opportunities which combine great challenges with the possibility of great rewards.

We think our progress to date in production sharing is encouraging. The dollar value of prime and subcontracts received this year is running at nearly the same level as last year, and significantly, the opportunities for Canadian firms to bid in response to U. S. requests have doubled in the same period.

Needless to say, all of our programmes for assisting the Canadian electronics industry, are based on the expectation that the Canadian electronics industry will make a corresponding effort. In the last analysis, our efforts can be justified only by the response which industry makes to them.

In fact the responsibility borne by industry goes far beyond the exploitation of opportunities created by the programmes of my department and the Department of National Defence. These programmes undoubtedly do provide a stimulus to technological and industrial growth. But I would be the first to recognize that industry itself is the chief architect of its own development. Governments can encourage; they can provide goals and opportunities; and, within limits, they can give financial support. But only industry can provide the drive — by its ingenuity, its energy and its willingness to take risks. I believe in Canadian industry, its management, its technicians, its workers, its dynamism. I believe they are going to make these programmes a great success. END

New agreements help Canadian firms

The Department of Defence Production has recently published a brochure entitled "Canada-United States Defence Production Sharing" which contains, or refers to, all the information Canadian manufacturers need about the production sharing program. CEE presents here the highlights of this document.

Canadian manufacturers **can** and **do** participate in U.S. defence business. The Canada-U.S. Defence Production Sharing Program announced in the fall of 1958 and now implemented by Canadian and U.S regulations has created a much more favorable atmosphere with the U.S. Armed Services and their contractors. These regulations enable Canadian firms to participate more freely as prime or subcontractors in U.S. defence business.

The U.S. Department of Defense Directive No. 2035.1 of July 28, 1960 implements the program in the United States (it appears as Appendix "A" to the DDP brochure). The bases for participation by Canadian companies are technical competence, price, delivery, and sales efforts in competition with U.S. firms. Many U.S. companies are actively supporting the program and are subcontracting to Canadian suppliers. A number of U.S. firms have sent evaluation teams to Canada to carry out industrial facility surveys.

Defence contracting to the U.S. Military Services is more competitive than to the Canadian Government due to the large number of bidders. The first essential, therefore, is that your prices be competitive. One of the aims of the Production Sharing Program is to encourage the U.S. military Contracting Officers and the U.S. defence contractors to consider Canadian supply sources; but no U.S. procurement will be directed to you unless you are the sole source for the product concerned. Generally speaking, you will have to compete with the other members of your industry on both sides of the border and your prices will have to be right. You must also be technically

New agreements help Canadian firms

competent and able to meet the required production schedules.

The U.S. Government can and does waive customs duties on the majority of Canadian materiel entering the U.S. for defence programs.

Generally the Buy American Act does not impose any penalty on your participation in U.S. defence programs. In almost all instances you are at no disadvantage in competitive bidding with U.S. industry.

Security clearances are necessary to discuss the classified portions of a U.S. program whether the prospective supplier is Canadian or American. U.S. Service Procurement Agencies and U.S. contractors are just as free to discuss the unclassified portions with you as with any U.S. company.

Lists maintained

The Canadian Department of Defence Production (DDP) maintains a list of Canadian companies capable and desirous of active participation in the Production Sharing Program. The companies are allocated to the DDP Production Branches for purposes of general production sharing liaison; in this way you are assured of the availability of up-to-date information on the program. The branch to which you are allocated will provide brochures, commodity lists, bidder's application forms, etc. required by you, and will advise and assist you with any problems which may arise.

If your company is not listed as actively interested in the program, you should communicate with the director of the DDP Production Branch with which you normally deal (Mr. D. B. Mundy is Director of the Electronics Branch), or the Co-ordinator of Production Sharing whose address appears below, and indicate your interest in the program. The listing is revised regularly and retention of your company's name depends upon evidence of your continuing interest.

Assistance available

The department may extend special tooling and preproduction assistance to Canadian firms, and development assistance as noted below. Details of the conditions and type of assistance which may be available are obtainable from the DDP Branch with which you normally deal, to whom all applications for assistance should be addressed.

Enquiries regarding any questions or problems which may arise should be addressed to the DDP Branch with which you normally deal, or:

Co-ordinator of Production Sharing,
Department of Defence Production,
Temporary Building No. 2,
Ottawa, Ontario.

If your U.S. customers have any questions or suggestions they may write or call:

Director,
Department of Defence Production,
P.O. Box 4897, Cleveland Park Station,
Washington 8, D.C.
Telephone: HUdson 3-5505;

or the nearest DDP Liaison Officer. These are located in New York City; Rome, N.Y.; Dayton, Ohio; Los Angeles, Calif.; and Boston, Mass. Full names, addresses and telephone numbers are included in the brochure, of which copies are available free of charge from DDP.

References

The following U.S. Department of Defense procurement regulations are referred to extensively in the brochure and contain much useful detailed information:

Armed Services Procurement Regulation (ASPR)
This is the basic procurement regulation of the U.S. Department of Defense. The three separate procurement instructions of the U.S. Armed Services are derived from ASPR. This publication is available to you if you wish to purchase it. At the present time, the publication with all changes to date is selling on a subscription basis for $18.00. You will automatically receive future revisions as published. The subscription covers a period of two years. Pertinent sections of ASPR are quoted verbatim in Appendix "B" to the DDP brochure.

Army Procurement Procedure (APP)
This book may be purchased for $8.45. At your request revisions and their prices will be drawn to your attention as published.

Air Force Procurement Instruction (AFPI)
This publication is sold on a subscription basis at $28.00 per annum. Revisions are included.

Navy Procurement Directives (NPD)
This is also sold on a subscription basis. The price of $7.00 includes all revisions for an indefinite period.

You may purchase these publications or obtain further information about them from:

U.S. Government Printing Office,
Washington, D.C.

All prices are in U.S. funds. There are no extra charges for mailing to Canada.

Prime contracting

If you intend to seek prime contracts directly from the U.S. Service procurement agencies, you should remember that their regulations normally require that they place prime contracts for Canadian production on the Canadian Commercial Corporation. This a Canadian Crown Company wholly owned by the Canadian Government which is especially well equipped to administer U.S. Service contracts in Canada.

The Canadian Commercial Corporation (CCC) through DDP places a Canadian contract on you as the actual supplier. CCC does not take a profit or fee on your business with the U.S. Government. This arrangement has proven satisfactory to the U.S. Services and has advantages for you in that your contract will be awarded and administered by a Canadian government department. Your tenders must be submitted through the DDP Branch concerned to CCC, unless you have received instructions to the contrary from the U.S. procurement agency, DDP or CCC.

This contractual procedure does not affect your selling activities. You still carry on your own promotional work with the U.S. procurement agencies. However, DDP can give you guidance in getting on U.S. Service bidders' mailing lists and in other representational matters.

Subcontracting

The DDP production branches in Ottawa are often aware of U.S. military programs which are of particular interest to you as a potential supplier and can advise you on them and the specific U.S. contractors concerned. Essentially, however, you are on your own.

Because U.S. defence contractors are located at widely scattered points of the United States, you may need to enlist outside sales representation to properly canvass them. You will find suggestions about locating and selecting sales representatives in the brochure. Persistent contact with U.S. companies can help you build up their confidence in you and develop a willingness to use you as a supplier in their defence programs.

Development sharing

An essential pre-requisite to the long-term success of the Production Sharing Program is participation by Canadian companies in Research and Development (R&D) leading to the production of modern defence materiel.

Publications are available from DDP which give guidance on participation in U.S. funded R&D projects. They describe the fields of interest of the U.S. R&D Agencies (Air Force, Army, Navy, NASA), how Canadian firms are listed, how bid sets are received, proposals submitted, etc. The majority of R&D opportunities are in connection with these U.S. funded projects and capable Canadian companies have equal opportunity with their U.S. counterparts to share in this business either as prime or sub-contractors.

As pointed out by Mr. Golden on page 28, funds are available for the support of other promising R&D projects that would be of interest to the U.S. military. Canadian firms which have the personnel, facilities and capabilities to perform R&D work should make known their interest to the DDP Branch with which they normally deal. The DDP Branch will then provide guidance to the company in this important aspect of the program.

Buy American Act

The Buy American Act restrictions have in effect recently been eliminated in regard to Canadian supplies for U.S. military supply and service contracts.

The Act, as passed in 1933, generally requires that U.S. Government Departments shall purchase only supplies which have been produced in the United States. However, the three U.S. Armed Services have now adopted a common basic procurement policy with regard to services and supplies of Canadian origin. The relevant sections of ASPR appear as Appendix "B" to the DDP brochure, and affect Canadian supplies as follows.

Prime contracting: For a selected list of products of mutual interest to the United States and Canada, the Buy American Act is waived with respect to Canadian competitive bids or proposals for prime contracts. In other words, Canadian materials and products are considered to be U.S. goods for the purposes of the Act. The excepted list of each U.S. Service has been expanded to include virtually everything the Service or its U.S. contractors could buy in Canada. The new lists appear as Appendix "C" to the brochure.

It is further provided that spare parts and ancillary or associated equipment for the listed products, which are called up by the same prime contract as the listed products, shall be regarded as U.S. products if they are Canadian supplies. More information on these listed products may be obtained from the DDP Branch with which you normally deal.

In U.S. Service procurement of all other products, Canadian competitive bids for prime contracts will henceforth be evaluated by adding only the applicable U.S. duty to the Canadian bid. No other differential is added.

Sub-contracting: When a U. S. defence contractor is incorporating Canadian supplies, whether the supplies are listed or not, they are considered to be U.S. material for the purposes of the Act. Thus the U.S. prime or subcontractor at any level can buy anything up to 100% of the components of his product from a Canadian source.

U.S. contractors who are uninformed or who are reluctant to procure supplies of Canadian origin can be referred either to the ASPR or to the Buy American clause in their contracts to confirm that Canadian components are considered to be domestic. If necessary, a U.S. prime contractor may obtain from the Service Contracting Officer a ruling in writing concerning the proposed use of Canadian or foreign supplies.

Research and Development: The Buy American Act relates only to physical materials and is not concerned with contracts in which the supplier delivers findings resulting from an R&D contract. If such a supplier also delivers prototypes or other hardware, the above regulations regarding Canadian supplies are applicable. However, it is doubtful whether the Act would be invoked to prohibit such articles as they would be eligible for a waiver because of their non-availability in the United States.

The U.S. Army has specifically excepted from the restrictions of the Act all items procured under contract for experimental, research and development work.

U.S. duty-free entry

The U.S. Armed Services have special statutory authorization to arrange duty-free entry for their procurements from other countries. This duty-free entry can also be obtained for the import of supplies procured by U.S. military contractors.

On July 22, 1960 extensive changes were made in the duty-free entry regulations of the U.S. Armed Services. As these changes become effective, U.S. duty assessments and other U.S. tariff problems connected with your defence shipments to the United States will be almost eliminated.

The new regulations provide that within certain limitations, all products from Canada which are on the U.S. Services' list of products excepted from the Buy American Act and all Canadian parts for U.S. production of excepted list products shall be accorded duty-free entry.

However, you may find potential U.S. customers holding prior defence contracts which do not include the Canadian duty-free entry clause. You should urge such contractors to request the clause by amendment so that you may offer your products to them on a duty-free basis. The U.S. Services' excepted lists are now so inclusive that almost all contracts will be eligible.

Because the immediate benefits of a waiver of duty accrue to the U.S. Service rather than to the importing contractor, it may be necessary to remind your U.S. customer of the advantages to him through having the contract amended, including probably a lower price than that for competitive U.S. products.

Other topics

Also covered in detail in the brochure are other areas of interest to potential Canadian suppliers. These include drawback of Canadian duty, security clearance arrangements, priorities and allocations, reciprocal inspection and auditing. Another subject of particular interest to Canadian component parts and materials manufacturers — reciprocal qualification approval — is fully described by Mr. A. P. Harris of CAMESA in his article on the next two pages. END

A. P. HARRIS, P.ENG*

New reciprocal approval agreement for qualification of electronic parts

As of July 20, 1960, a new agreement for mutual recognition of qualification approval of military electronic parts exists between the appropriate agencies in the United States and Canada. The essential features of the agreement and how they affect Canadian manufacturers are discussed here.

In order to expedite the production sharing agreement and to permit Canadian part manufacturers to qualify for U. S. orders, an earlier Qualification Approval agreement was signed between the United States and Canadian Governments on the 1st July 1958. This agreement covered all specifications under the mutual cognizance of the Canadian Military Electronics Standards Agency in Canada and the Armed Services Electro-Standards Agency in the United States. By this means, qualified Canadian products under approximately 160 specifications were eligible for listing on U. S. Qualified Products Lists as well as Canadian Lists.

As there were a substantial number of electronic parts and materials specifications which were still excluded from this agreement (they were not the mutual responsibility of the two agencies) it was decided in 1959 that further steps should be taken to expand the agreement for greatest possible application. Representatives of the Department of Defence Production and the Department of National Defence, therefore, worked with the Office of the Secretary, Assistant Secretary of Defense Supply and Logistics, in the United States, to draft a new agreement which became effective on 20 July 1960.

Scope of agreement

The scope of the current agreement is indicated in Table I. It will be seen that the parts and materials now eligible for qualification in both countries are identified by Federal Supply Classification categories. Resistors for example fall within FSC number 5905. Identification by this system was chosen as it forms the basis of the U. S. supply system and is recognized by supply and logistic groups of both countries.

It should be noted, however, that the categories in Table I cover a broad range of items, not all of which are eligible for qualification action. It is the intent, at this time, that the agreement apply only to electronic and related electrical parts and materials, and certain limitations apply as indicated by the notes in the "Remarks" column.

*CAMESA, Dept. of National Defence (Air), Ottawa.

Procedure for Canadian part manufacturers

Under the new agreement the procedure that a Canadian Part Manufacturer must undertake to have his product listed on the appropriate Qualified Products List in the United States is as follows:

Step 1: A Canadian Electronics Part Manufacturer must have received Qualification Approval from the Canadian Military Electronics Standards Agency. A specification under which he receives approval must be of the same issue and date as that currently in effect in the United States.

Step 2: A Canadian Part Manufacturer should then request CAMESA to apply to the appropriate qualification authority in the United States for recognition of the Canadian Approval and listing on the United States Qualified Products Lists. CAMESA, upon receipt of this request, will forward to the United States Qualifying Agency certain technical information including test reports and related engineering data for their consideration. If the tests upon which qualification were based were done in a test facility located in the Canadian plant, then a report on the test facility will also be forwarded.

Step 3: The United States Qualifying Agency has 60 days upon receipt of the application to advise the Canadian Part Manufacturer if they are prepared to recognize the approval and subsequently place the name of the Canadian company on the U. S. Qualified Products List. At this stage correspondence will take place directly between the Canadian Part Manufacturer and the U. S. Qualifying Agency. If for some reason (that is, some technical reason) U. S. Qualifying Agency does not feel the supporting test data is adequate, the Canadian company will be so advised and a request made for further information.

With his name on the U. S. Qualified Products List all technical barriers towards acceptance of the product have been removed for most U. S. contracts calling up MIL parts specs. This listing of course does not guarantee the receipt of orders or remove the problems of competitive price and delivery.

A copy of the complete agreement now forms a portion of CAMESA Document SB-1 which relates to the conditions and procedures for Qualification Approval of Electronic Parts and Materials by the Department of National Defence. A copy of this document can be had by any Canadian Part Manufacturer on request.

Potential problems for Canadian manufacturers

Experience with the previous agreement indicates that certain pitfalls exist which the Canadian Part Manufacturer should take steps to overcome if he wishes to receive and maintain his listing on the United States Qualified Products Lts.

The first of these is the problem of maintaining Qualification Approvals up-to-date in Canada. It has been the experience of CAMESA that at least 60% of the applications for listing had been rejected because the Canadian Part Manufacturer had not maintained his Qualification Approval up-to-date under the current issue of the specification that exists in Canada and the United States. Part Manufacturers are therefore urged to apply for Qualification at the earliest possible date and to maintain this approval by immediate action as soon as specifications are modified or reissued.

(News about specifications can be found in the department, CAMESA News, carried each month in CEE).

Once listed on U. S. Qualified Products List the United States Qualifying Authority will normally give the Canadian Part Manufacturer a fixed period of time within which to re-establish the qualification once the specification has been changed or reissued. This period of time can vary from 40 to 180 days and during this time, it may be necessary for the Canadian Part Manufacturer to arrange by himself, or through CAMESA, the performance of certain tests to ensure that the new requirements of the new specification are being met. (This action must be taken through, or with the knowledge of, CAMESA).

To avoid complications Canadian Part Manufacturers should provide engineering data promptly to either agency upon request.

The staff of the Canadian Military Electronics Standards Agency is prepared to offer all possible assistance in resolving the technical problems of qualifications, and Part Manufacturers who wish further information should apply to the following:

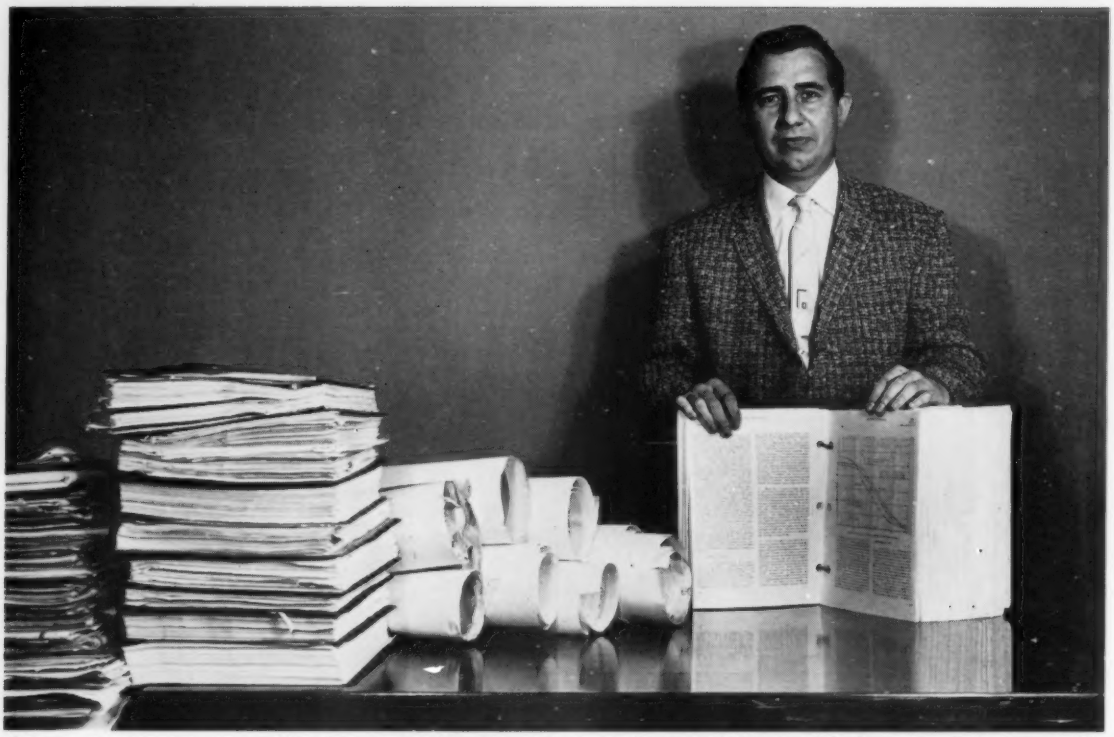
The Director,
Canadian Military Electronics Standards Agency,
Department of National Defence (Air),
Ottawa, Ontario.
Attention: Approvals Division (for all FSC Classes except 5960).
Attention: Electron Devices Division (for FSC Class 5960).

The telephone numbers of the Approvals Division in Ottawa are:

Central 2-8211, Extension 6-8570, and Extension 2-5049. For the Electron Devices Division it is Central 2-8211, Extension 6-8664. END

F.S. Class	Title	Remarks
2920	Engine, Electrical System Components, Aircraft	Suppressor components only
2925	Engine, Electrical System Components, Non-Aircraft	Suppressor components only
3439	Miscellaneous Welding, Soldering, and Brazing Supplies and Accessories	Limited to solder, fluxes and related materials.
4020	Fiber Rope, Cordage and Twine	Twines and cordage for cables.
4450	Industrial Fan and Blower Equipment	Electronic fans and blowers
5340	Miscellaneous Hardware	
5835	Sound Recording and Reproducing Equipment	Magnetic recording tapes and related material only
5905	Resistors	
5910	Capacitors	
5915	Filters and Networks	
5920	Fuses and Lightning Arresters	Limited to electronic parts
5925	Circuit Breakers	
5930	Switches	
5935	Connectors, Electrical	
5940	Lugs, Terminals and Terminal Strips	
5945	Relays, Contactors, Solenoids	
5950	Coils and Transformers	
5955	Piezo Electric Crystals	
5960	Electron Tubes, Transistors and Rectifying Crystals	
5965	Headsets, Handsets, Microphones and Speakers	
5970	Electrical Insulators and Insulating Materials	
5975	Electrical Hardware and Supplies	
5977	Electrical Contact Brushes and Electrodes	
5985	Antennae Waveguides and Related Equipment	
5990	Synchros and Resolvers	
5995	Cable, Cord, and Wire Assemblies	
5999	Miscellaneous Electrical and Electronic Components	
6105	Motors Electrical	
6125	Converters, Electrical	
6130	Rectifying Equipment	Rectifiers as parts only
6135	Batteries, Primary	
6140	Batteries, Secondary	
6145	Wire and Cable, Electrical	
6240	Electric Lamps	
6625	Electronic and Electrical Properties Measure and Testing Instruments	
6635	Physical Properties Testing Equipment	
6640	Laboratory Equipment	
9330	Plastic Fabricated Materials	

Table 1. Scope of reciprocity for qualification between the United States and Canada



Engineers' notes, parts specifications and schematics, left, provide part of information for manual shown at right.

Production sharing requires different approach to technical publications

Defence production sharing contracts normally call for technical publications to be prepared in accordance with U. S. specifications for delivery with the equipment. This article discusses some of the differences between Canadian and American specifications, then points out that a well-organized approach to technical publications is needed.

J. F. KEAY

Cushing & Nevell Ltd., Toronto.

Now that Defence Production Sharing has become a reality, Canadian manufacturers may become involved in producing technical publications in accordance with American specifications. A publication requirement is normally part of an over-all equipment contract and the cost of producing the books can be substantial.

Because of the many variables which must be considered in estimating the cost of a publication, a manufacturer may quote a price which is low. This can mean a financial loss on the project. Alternatively, he may quote a price that is high, which can mean the loss of the contract.

Factors to consider in estimating

There are three major factors to consider when estimating the cost of publications. They are specifications, delivery and production.

Publications here are taken to mean all written or illustrated matter required within the terms of the contract. This includes such items as Provisioning Parts Breakdown, Stock Parts List, Illustrated Parts Breakdown,

text, illustrations and photographs for Technical Manuals.

Specifications

Specifications are a pre-requisite in determining the cost of a publication. The applicable specifications are always called up in a military contract and copies are available at nominal cost from the Department of National Defence Liaison Service. But this still leaves the manufacturer with the problem of interpreting the specifications before he can determine how much it will cost to produce the publications.

Canadian Service publications are governed by one or two specifications in most cases. By contrast, Defence Production Sharing (DPS) publications may be governed by as many as twelve different American specifications.

For example, a DPS publication consisting of 100 pages may have the operating instructions written to MIL-H-7257, the service instructions written to MIL-H-6757A, the overhaul instructions written to MIL-H-6814A, the installation instructions written to MIL-H-4978A and the illustrated parts breakdown done in accordance with MIL-B-5005A. In addition, there are specifications which govern preparation of copy, preparation of offset negatives, printing, etc.

A similar publication, if it were produced for the Royal Canadian Air Force, would be done in accordance with two specifications, PROC 100-9 and 33-GP-1P.

Canadian Services, being much smaller than their American counterparts, do not have the complexity of organization found in the United States. For this reason it is possible to place all their instruction book requirements into one or two large specifications. The Americans use a multitude of small specifications in order to have flexibility compatible with their type of organization. On top of this there are many differences required in the content of the manuals.

To show one difference between Canadian and American publication specifications a comparison can be made between the format for parts listing of electronic components as specified in the Canadian PROC 100-9 and the American MIL-5005A.

The American specification requires photographs of the equipment with all components annotated and accompanied by a parts listing containing only a brief description of each part.

The Canadian specification calls for schematics with circuit reference symbols, accompanied by a parts list containing more lengthy descriptions.

Delivery

Some of the Canadian Services call for the major publications to be produced after the equipment is built. American contracts, on the other hand, require the publications to be produced at the same time the equipment is being manufactured so they can be delivered with the equipment.

Needless to say, if the publication is not delivered on schedule, payments can be withheld. This can be costly for the manufacturer and may also result in loss of future sales.

Production

In considering the production of a technical publication

American publication contracts involve many small specifications, left. Canadians use few, comprehensive ones.

a manufacturer has a choice of three courses. He can hire a writing and illustrating staff and develop his own publication group; he can place the load on his engineering staff; or he can subcontract the work to a technical writing firm.

In many instances, manufacturers with publication groups sub-contract a part of their writing and illustrating requirements to writing firms. It is a convenient and economical way of handling peak loads and special requirements.

The term "publication group" as used in this article can mean the addition of a few people to an existing department, or it can mean the establishment of a complete publication department. What this term encompasses will normally be determined by the size of the publication requirement.

Establishing a publication group

The establishment of a publication group can be a costly venture if the group is assembled for the production of one publication. And, of course, no matter how big or small the publication is, such items as space rent, equipment, recruitment, supervision and salaries must be considered. Also, because of the number of specifications and their relative complexity, a certain length of time must be allowed for the new personnel to become familiar with them. This is minimized with experienced personnel, but such people are not easy to find in Canada, and they may not be interested in working for only a short period of time.

Publications prepared in the engineering department

The manufacturer may decide to place his publication requirements in the hands of his engineering staff. This procedure, however, can be a drain on production and engineering time. During the equipment production phase the engineering staff will be occupied with the many problems which always arise. The addition of another burden could result in delaying production of both equipment and publications.

There are other problems. Without prior experience, the engineering staff would not be capable of providing a sensible quotation for preparation of publications. In addition, it is unlikely that an engineering department

Technical publications

would be staffed with illustrators, reproducible copy specialists, layout personnel, photographers — or writers. The absence of such people can cause more delays.

Another important point to remember is that the design engineers become so familiar with the equipment it is difficult for them to appreciate the problems facing operators and maintenance personnel.

On the other hand, however, because the design engineers have so much knowledge about the equipment, they must schedule time to give their information, either verbally or in note form, to the people who will write the instruction manuals.

Sub-contracting to technical writing firms

Several writing firms have been operating in Canada since the early fifties. They maintain experienced staffs capable of interpreting specifications, judging the scope of publications, estimating costs, preparing artwork, etc. They are organized to produce any publication, large or small, and some have personnel with extensive experience in the production of technical publications to American specifications.

Manufacturers may be reluctant to sub-contract to a writing firm on the basis that the writing firm cannot be as familiar with the equipment as are the design engineers. This is true, but it must not be forgotten that the personnel of writing firms are well trained and experienced. They may even have written and illustrated books on similar equipment, or an earlier version of the same equipment. Also, they are familiar with the specifications.

In any writing project someone must devote time to learning. The design engineer would have to take time to learn the specifications and how to write; a writer would have to take time to learn about the equipment. Experience has shown that in the majority of cases the most economical and successful way of handling a writing project is to combine the skills of the design engineer and the writer. The design engineer provides the basic information (much of it may exist in his reports) and the writer uses it to produce the manuscript.

The way in which a writer fits into the scheme will be much the same whether he is employed by a writing firm, or on the manufacturer's publications staff.

Timing and planning

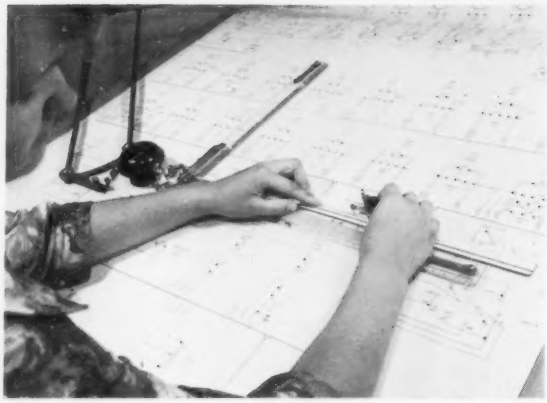
Whether a manufacturer uses the services of a technical writing firm or his own publications staff, timing and planning are important.

If he decides to use the services of a writing firm he should call them in at the very beginning and get their estimates at the bidding stage. This is important to both the manufacturer and the writing firm.

A writing firm is capable of preparing a realistic cost estimate based on past experience and known facts about the new project. They can also tell the manufacturer the approximate number of hours that will be required from his engineering staff to provide basic information, and review draft copies of the publications.

Other information, such as delivery schedules, interpretation of specifications, etc., can be helpful to the manufacturer when he is preparing his bid.

It is important to the writing firm that it be consulted at the bidding stage so it can get an over-all picture of the project and fit the job, at least potentially, into its own production schedule to insure that the publications will be delivered with the equipment.



Planning schematics to suit engineering and publication requirements can avoid costly duplication of drafting.

Production costs

The question of cost per page for technical publications often arises. It is almost impossible to provide any over-all figure because there are so many variables involved. Some of these are: the condition and scope of the existing information; complexity of the equipment; existence and condition of the design engineer's reports; condition of schematics; existence of photographs and their suitability for publication; specifications involved; and whether the contract calls for reproducible copy, negatives, or printed copies.

It is logical that each publication should be judged as an entity and the cost estimate should be made after considering all the variables.

Keeping cost down

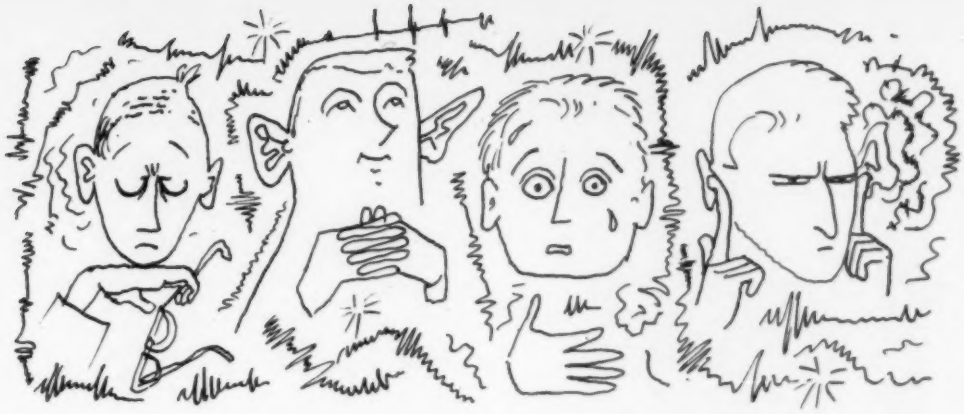
Whether the manufacturer decides to produce the publication himself or sub-contract to a technical writing firm, he can do much to keep the cost of the publication down. He should make his staff publication-conscious from the start of the project. In the research and development stages such things as good engineering reports, test specifications, performance data and progress reports can be money savers.

As the project progresses other money savers will appear. For instance, care and control should be exercised when photographs are being taken. It should be decided what photographs are required and the angles from which they should be taken. Then the best possible quality in the photographs should be insisted upon. A good photograph will eliminate much expensive retouching time.

Blueprints, schematics, wiring diagrams, etc., should be drawn using standard symbols. The size and shape of the drawing should be such that a reduced reproduction can be fitted into a book without costly alterations.

Publications are an important part of a contract and they are essential to the successful installation and operation of the equipment. In turn, they must be well written and illustrated. This requires good planning and efficient handling.

END



Electronic music at Stratford

ROBERT TANNER, FELLOW I.R.E.*

Mr. Tanner attended a concert of electronic music which formed part of this year's Music Festival at Stratford, Ontario. He gives here his comments on the concert, and wishes to emphasize that these are his own personal opinions.

A concert of considerable interest to electronic engineers took place recently in the Festival Theatre at Stratford, Ontario, as part of the International Conference of Composers held there between August 7 and 14. Believed to be Canada's first complete concert of Electronic Music, it was preceded in the morning of Friday, August 12, by a panel discussion in which Dr. Hugh LeCaine of the National Research Council took a prominent part. Unfortunately, I was unable to attend the discussion, and can report only at second hand that the panelists, under the chairmanship of Prof Otto Luening of Columbia University, explained the aims and objects of the works they were creating, and the methods, both technical and musical, they were using.

The concert itself in the afternoon consisted of seven works from the Netherlands, Milan and New York, and covered the present field of this new art form with some completeness. No one could fail to be impressed with the great and painstaking effort which went into many of these compositions, but to the ear trained to appreciate the more usual forms of music, some of them ventured so far afield as to offer little pleasure or entertainment.

Speaking purely personally as an electronic and acoustical engineer, I was struck by the fact that, with the whole immense range of sounds at their disposal, so many of the composers represented on the program appeared to concentrate on the high frequencies, the percussive and disjointed sounds, and, oddly enough, on silence. Since the tape recorder has become such an essential tool in the preparation of these works, some of the composers seem to have become infatuated with the sounds it makes when run too fast or backwards, as well as its ability to allow the same sound to be repeated as often and as rapidly as desired. As a result there is a tendency to use these recorder techniques to the exclusion of the many others at their disposal, giving a sameness and monotony which a greater understanding of the field might eliminate.

The tapes were played on a two-track machine, feeding loudspeakers on either side of the stage (the equipment was supplied by Dominion Electrohome of Kitchener) but surprisingly little use was made of the ability to give the impression of sound sources in between the loudspeakers. In general, the sounds emanated from either one side or the other, and often switched between speakers with bewildering irregularity. It was not at all clear whether these effects were intentional or again due to lack of complete understanding.

It is such points as these that make the present endeavors in the electronic music field somewhat annoying and frustrating to the engineer. We have labored long and hard to study, understand and expound the technical aspects of the subject and have been successful in applying it to better and better reproduction of wonderful sounds. But when it comes to the use of what we have come to think of our techniques in the production of music, the present workers appear to be restricting themselves quite unnecessarily by preconceived ideas, and lack of understanding. As a result, many of their works do not have the continuity and rhythm which surely is the basic foundation of all true music.

Fortunately there were exceptions at the Stratford concert to this general criticism: Henk Bradings' Capriccio for violin and electronic accompaniment kept closer to the main stream of music, while the works of Otto Luening and Vladimir Ussachevsky of the Columbia and Princeton School of Electronic Music possessed a breadth of tone and continuity of line which made them more acceptable to the uninitiated ear.

Other "compositions" by Bruno Maderna, Luciano Berio and John Cage made great use of the human voice, uttering words or "phonemes" (nonsense syllables) as a primary sound source. The most extreme of these, by John Cage, appeared to assemble its components on the basis of pure chance; surely this is the complete antithesis of music, which may be defined as an organized and logical arrangement of sounds, designed to please, move, entertain, or otherwise play on the senses and emotions of its hearers. The main effect of this work on the audience was

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*Northern Electric Co. Ltd., Research and Development Laboratories, Ottawa.

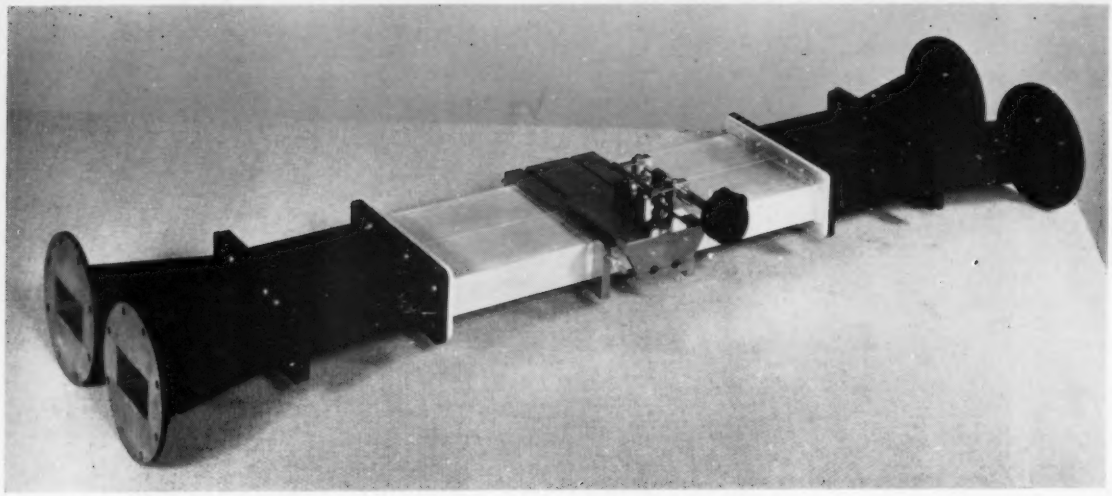

Figure 1.

Simple power divider for microwaves is continuously variable

This continuously variable microwave power divider uses one fixed and one movable polystyrene strip as the dielectric to achieve phase shift. It has low insertion loss, low reflection of incident power and high maximum value of attenuation.

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In microwave systems it is often desirable to be able to vary the coupling of a transmitter to a load, or to divide the power output of a transmitter between two loads. A continuously variable power divider provides an effective means for accomplishing these objectives. Since frequency pulling of microwave transmitters is generally serious, partly because of the usual lack of any buffer stages between the oscillator and the load, it is particularly important that any such device should not cause large reflections of incident power. Obviously desirable are such features as low insertion loss and satisfactory operation over a wide frequency range. For use as a variable attenuator, a high maximum value of attenuation is desirable.

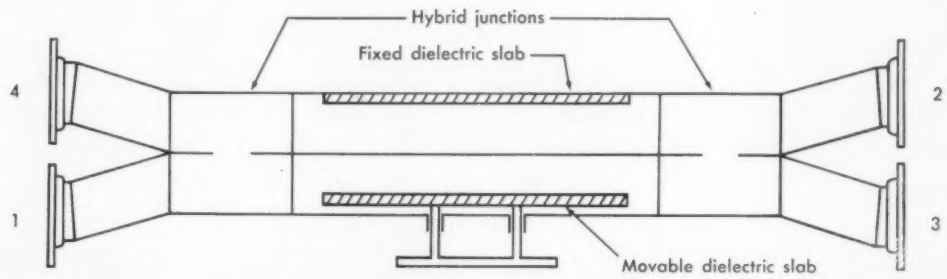

Fig. 2. Schematic diagram of variable ratio power divider

This paper describes a microwave power divider which has three attributes, and in addition, is mechanically simple and useful at high peak power levels. A model of this power divider has been constructed at the National Research Council Laboratories and is shown in Figure 1. It has properties similar to the power divider described by Teeter and Bushore[1], but it is simpler and of different configuration.

The power divider, illustrated schematically in Figure 2, comprises a pair of waveguide hybrid junctions[2], a dual phase shifter connected between the hybrid junctions, and a pair of waveguide adapters which provide for the connection of standard waveguide equipment to the device. The dual phase shifter consists of two equal lengths of waveguide joined as illustrated along a common narrow wall; each section contains a slab of polystyrene, tapered at each end. The dimensions of the polystyrene slab are chosen so as to provide a variation in phase shift of at least 180 deg. when the slab is moved from a position against the waveguide wall to a position central in the waveguide. Design data for the phase shift section is given by Raglan[3]. The fixed dielectric slab is required to compensate for the minimum phase shift obtained when the movable slab is against the waveguide wall.

Operation

When power is applied to one of the ports of the device, e.g. Port 1 (see Fig. 2), the power enters the first hybrid junction where it is divided, one half being transferred to the adjacent waveguide, where it continues to propagate in the same direction (i.e. to the right in Fig. 2), while the remainder of the power continues to propagate in the main waveguide. The properties of the hybrid junction are such that after leaving the junction there is a 90 deg. phase difference between the waves in the main and adjacent waveguides; the signal in the main waveguide leading the signal in the adjacent waveguide. If each section of the dual phase shifter introduces the same wave shift, the waves enter the second hybrid junction with 90 deg. phase difference, and by reciprocity, the power recombines and leaves by Port 2. If, however, a larger phase shift is introduced on one side of the dual phase shift section than on the other, some of the power will leave by Port 3, and the remainder by Port 2. Such a differential phase shift can be produced by moving one dielectric slab toward the centre of the waveguide, while keeping the other fixed. The amount of power leaving Port 3 increases continuously as the dielectric slab is moved toward the centre, reaching one half the input power when a differential phase shift of 90 deg. is produced. When the differential phase shift reaches 180 deg., essentially all the input power is directed to Port 3. Conversely, the power leaving Port 2 continuously decreases as the differential phase shift is increased, approaching zero as the phase difference reaches 180 deg.

Since each slab is designed to provide minimum reflection, very little power is reflected back into Port 1. Port 4, normally unused, receives only slight amounts of power due to internal reflections within the hybrid junctions and phase shifter, and may therefore be terminated with a low power load.

The divider shown in Figure 1 was designed to operate over the frequency range of 2,700 to 2,900 mc, but will operate considerably beyond this range. It is constructed of standard RG48/U waveguide, and measures, with adapters, 6 in. x 13 in. x 42 in. A lead screw drive permits precise and easy positioning of the dielectric slab.

Electrical performance

The electrical characteristics are summarized in Figures 3 to 5, which give detailed information on the voltage standing wave ratio (VSWR), insertion loss, and power division capabilities. As may readily be seen, the divider exhibits low insertion loss and high isolation over a considerable frequency range. (Isolation is used here to denote the attenuation obtained between the input port and the unwanted output port with the slab in its extreme position.)

Figure 3 shows the maximum VSWR observed during movement of the slab. At most positions, the VSWR is considerably less than the values shown. The variation of VSWR is, moreover, free from rapid or erratic variations.

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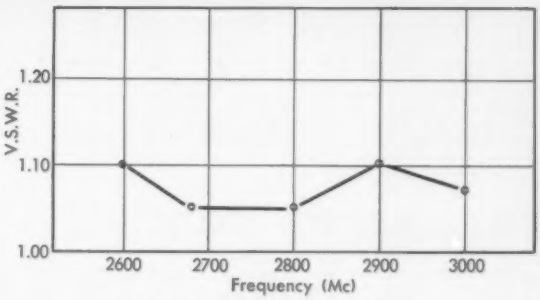


Fig. 3. Maximum V.S.W.R.

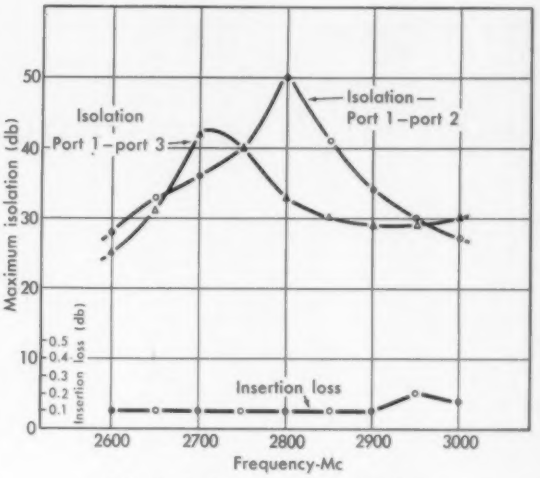


Fig. 4. Isolation and insertion loss

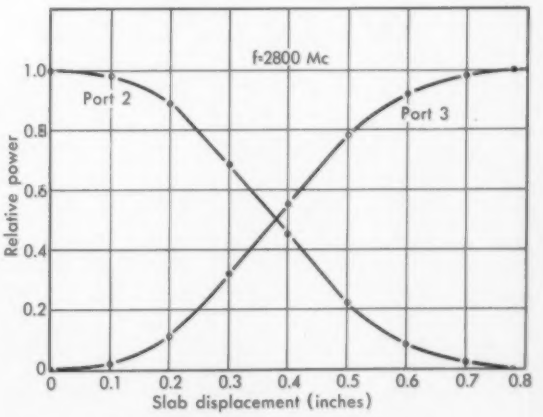
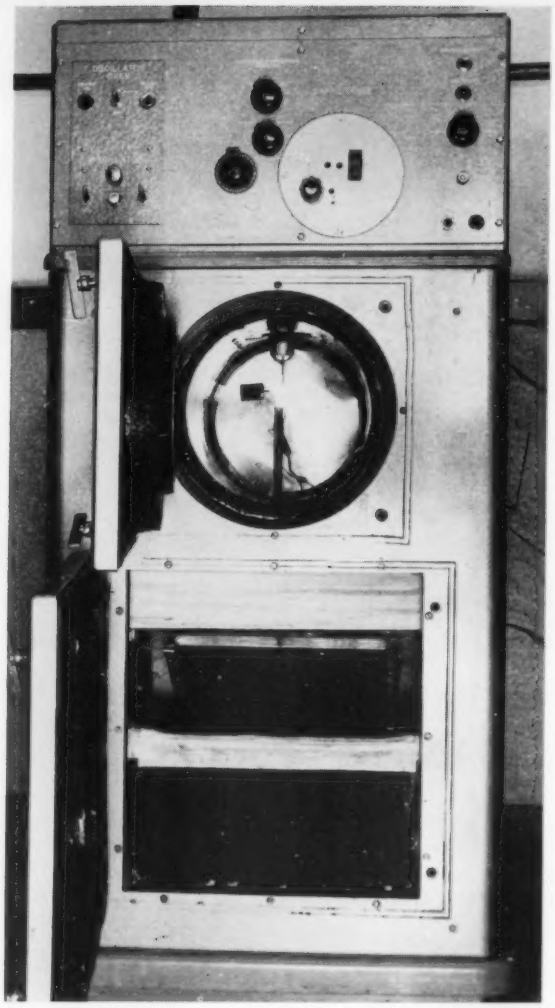


Fig. 5. Variation of output power

Simple apparatus measures temperature coefficient of components with high accuracy

C. REMPEL, MEM.I.R.E. &
H. REICHE, SEN.MEM.I.R.E., P.ENG.*



A simple, accurate laboratory test apparatus has been developed for measuring the temperature coefficient of components to determine their suitability for use in stable tuning circuits. The theory is given for the frequency shift method used, then the equipment and its operation are fully described. Accuracies of 0.7 ppm/deg C can easily be achieved.

The specification of modern military communications equipment demands a high degree of frequency stability over a wide temperature range. To achieve this, each tuned circuit must have a nearly zero temperature co-efficient. However, most of the conventional tuned circuit components have a substantial positive or negative temperature coefficient, so the design engineer must select a combination of components which together has a zero coefficient. To do this he needs full information on the temperature characteristics of the components that he proposes to use. This article describes a method and apparatus developed and used at the Army DevelopmentEstablishment (ADE) to provide this information.

Background and theory

Since there was no test equipment on the market which had the degree of accuracy required for these measurements a suitable system had to be developed. A search of the literature revealed that several methods had been tried. Cf these the frequency shift method appeared to be the most promising and was chosen because of its accuracy and relative simplicity.

The details of the design are based largely on the tests for fixed ceramic capacitors outlined in the specification MIL-C-20B, since these are the components which are generally used for temperature compensation. It will also be noted that this article is mainly concerned with the evaluation of ceramic capacitors, but it should be borne in mind that the apparatus is also used for testing other components.

The temperature coefficient of a capacitor is generally expressed in parts per million per degree centigrade or, in mathematical terms:

$$\alpha = \frac{\Delta C}{C_1} \times \frac{10^6}{\Delta t} \quad . \quad . \quad . \quad (1)$$

*Army Development Establishment,
Department of National Defence, Ottawa.

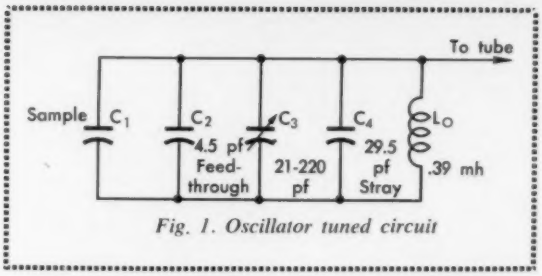


Fig. 1. Oscillator tuned circuit

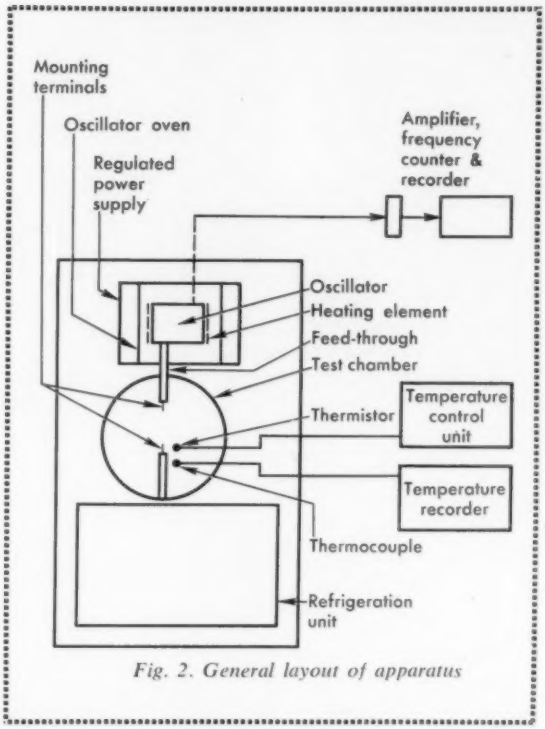


Fig. 2. General layout of apparatus

where α = temperature coefficient of sample
ΔC = change in capacitance over change in temperature of Δt
C_1 = capacitance at initial temperature

The following additional symbols are presented at this time to avoid repetition and confusion (see Fig. 1):

TC = temperature coefficient
f = oscillator frequency, cps
Δf = frequency shift or increment, cps
C_2 = capacitance of feedthrough
C_3 = variable capacitance
C_4 = residual capacitance of tuned circuit
$C_0 = C_2 + C_3 + C_4$
L_0 = inductance of tuned circuit.

It can be seen that the basic problem in determining α is to evaluate ΔC. This can be done quite easily by the substitution method if ΔC is large, as is the case for high values of C and α. However, a direct measurement of minute values of ΔC is not practicable, so the frequency shift method is used.

Frequency shift method

This method is based on the change of a known and accurate frequency source through temperature dependence of one of its circuit components.

The sample to be tested is connected in parallel with the tuned circuit of a variable frequency oscillator so that any change in the value of the sample causes a corresponding change in the oscillator frequency. The capacitor is then subjected to a known temperature change while the oscillator temperature is held constant. The resulting frequency shift can be translated into the corresponding ΔC, and thence α, by applying the formula:

$$\alpha = \frac{2\Delta f}{f} \times \frac{(C_1 + C_0)}{C_1} \times \frac{10^6}{\Delta t} \quad . \quad . \quad (2)$$

The photograph and the block diagram (Fig. 2) show the general arrangement of the test apparatus. Each of the individual units are described below in some detail.

Oscillator

Since the frequency shift is used to determine the TC it is important that the change in frequency obtained as a result of subjecting the sample to a change in temperature is due only to the change in the value of the sample. The stability of the oscillator must be such that it does not change of its own accord while the test is being run, a period of one to two hours.

The Franklin circuit shown in Fig. 3 was selected for this application since it was also used in an earlier set-up and was found to be satisfactory. However the circuit itself is only a part of the stability problem. Every precaution must be taken to ensure that there are no mechanical changes and that the oscillator temperature is kept constant. To meet the first of these requirements the oscillator is mounted on a heavy cast aluminum chassis which in turn is mounted in a heavy cast aluminum box. This box is surrounded by a twenty-watt thermostatically controlled heating element which holds the temperature constant at 55 C. The box with its heating element is enclosed in an aluminum cabinet lined with two inches of glass wool insulation. As a further precaution, all mechanical connections leading to the oscillator controls are disengaged during tests so that no mechanical forces are transmitted from the external parts to the oscillator chassis.

An attempt was made during the early stages of development to provide switching arrangements which would make the equipment more versatile. These added to the stray capacitance which varied with switching, causing frequency shifts; they were therefore abandoned.

The ceramic capacitors listed in MIL-C-20 cover a capacitance range of 0.5 to 1300 pf and the TC ranges from +200 to −750 ppm/deg C. As stated earlier the TC of large capacitors can be evaluated more easily by the substitution method; the Δf method is normally used for units with a capacitance of less than 100 pf.

The test frequency specified is 1 Mc. Since the oscillator frequency is determined by L_0 and C_0 it is necessary to vary either C_3 or L_0 to tune the circuit to the required frequency (see Fig. 1). Another point to

bear in mind is that C_0 must be kept as small as possible with respect to C_1 in order to ensure maximum sensitivity.

In this application C_3 serves as the variable component and is a 21-220 pf precision variable capacitor. Arrangements have also been made for different values of L_0 to be wired into the circuit, according to the value of the sample to be tested.

Feedthrough

A special quartz glass coaxial feedthrough, shown in Fig. 4, connects the sample in the chamber to the tuned circuit. The requirements that the feedthrough was designed to meet are as follows:

a. It must be able to withstand temperatures from −55 to +85 C and temperature gradients between its ends of 110 C.
b. It should not conduct enough heat to affect either the sample or the oscillator.
c. Its capacitance should be low. The one used in the ADE equipment has a capacitance of 4.5 pf.
d. It must be rigid and must be securely fastened to the oscillator chassis so that there can be no changes in the stray capacitance.
e. Its *TC* must be consistent so that its effect on the frequency change can be taken into account. To do this a run is first made with no sample connected and the magnitude and direction of the frequency shift is noted. When a sample is subjected to a similar run correction can be made by adding or subtracting this amount, as required, from the shift obtained with the sample. The Δf caused by the feedthrough in this equipment is 25 cps for a temperature change of 60 C.

DERIVATION OF FORMULA FOR α

The resonant frequency of the tuned circuit of figure 1 is given by

$$f = \frac{1}{2\pi\sqrt{L_0(C_1 + C_0)}} .$$

Since L_0 and C_0 are held at constant temperature and only C_1 is a function of temperature, the total differential of f is

$$df = -\frac{1}{2}\left(\frac{1}{2\pi\sqrt{L_0(C_1 + C_0)}}\right) \cdot \frac{dC_1}{C_1 + C_0} .$$

Hence $$dC_1 = -\frac{2(C_1 + C_0)df}{f}$$

or $$\frac{dC_1}{C_1} = -\frac{2(C_1 + C_0)df}{C_1 f} .$$

Expressed in increments this becomes

$$\frac{\Delta C_1}{C_1} = -\frac{2(C_1 + C_0)\Delta f}{C_1 f} ,$$

Substituting in equation (1)

$$\alpha = -\frac{2(C_1 + C_0)\Delta f}{C_1 f} \times \frac{10^6}{t} \quad . \quad . \quad (2)$$

Test chamber and associated equipment

Suitable commercial test chambers are available but they are rather costly. Since the equipment was intended for laboratory use and not for large quantity testing, it was decided to develop a small unit using a dry ice cooling system.

The apparatus was also to be used for the evaluation of air dielectric capacitors so a heat exchange system was incorporated to exclude carbon dioxide from the test chamber.

Fig. 6 illustrates the arrangement of the test chamber, circulating fan, heating and cooling elements and the system of ducts. The operation is as follows: Dry ice and alcohol are placed in the lower tank and the alcohol is pumped through the heat exchanger—a small section of an automobile radiator core. Heating and cooling of the chamber is achieved by directing the flow of air through the cooling or the heating sections as required.

The chamber temperature is controlled automatically by a servo system. The temperature sensing element, a thermistor, is mounted inside the chamber and forms one arm of an AC bridge circuit; the other arm, a variable resistor, is used to order the temperature required. The servomechanism responds to the bridge output and continuously adjusts the butterfly valve and the heater control until the chamber temperature is stabilized at the desired point. The time required to change the temperature from one extreme to the other is approximately 30 minutes.

Frequency counter

The frequency shift obtained is measured by means of a conventional counter which has an accuracy of ±1 part per million. A recording unit is also provided so that the oscillator stability can be checked continuously over a long period of time. The counter is capacitively coupled to the oscillator, but the coupling is kept loose so that the counter and the connecting lead can have no effect on the oscillator frequency.

Power supply

The oscillator is quite sensitive to voltage changes and a regulated power supply has therefore been incorporated. In addition to this a line voltage regulator is provided for the oscillator and the remainder of the equipment.

Temperature cycle

The temperature cycle specified in MIL-C-20B is 25, −55, −40, −10, +25, +45, +65, +85 and +25 C. This order of cycling was apparently chosen because less time is required to pull the temperature down from 25 C than from 85 C, as would be the case if the cycle were reversed. However the reverse cycle gives more consistent results if condensation is a factor. This is so because in the change from 85 to −55 C the temperature of the sample, which lags the ambient temperature, is always higher than that of the surrounding air and consequently condensation is low. On the other hand, if the temperature change is from −55 to +85 C, the component temperature is always below the ambient temperature and condensa-

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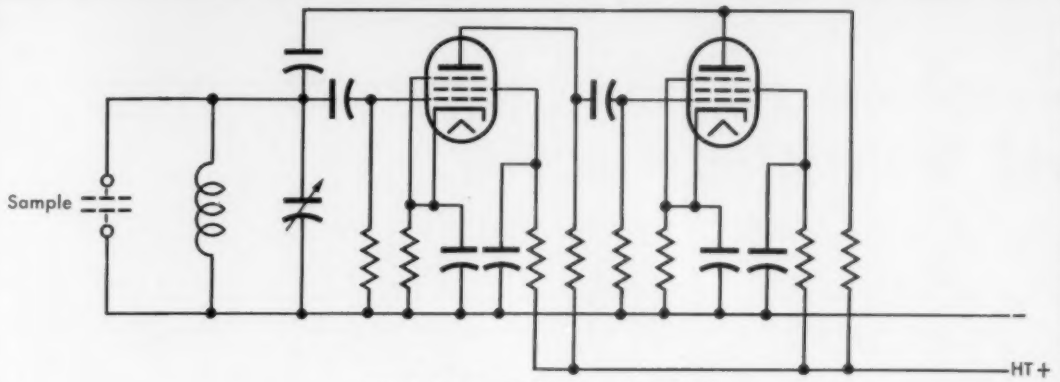

Fig. 3. Schematic diagram of oscillator

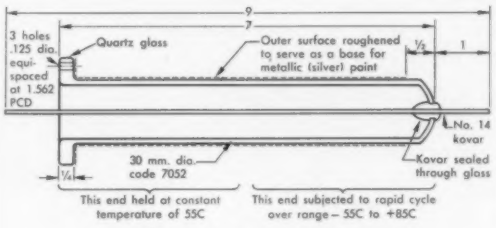

Fig. 4. Coaxial feed-through

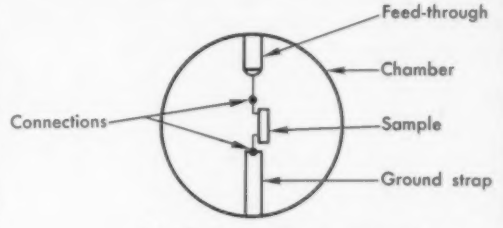

Fig. 5. Mounting arrangement

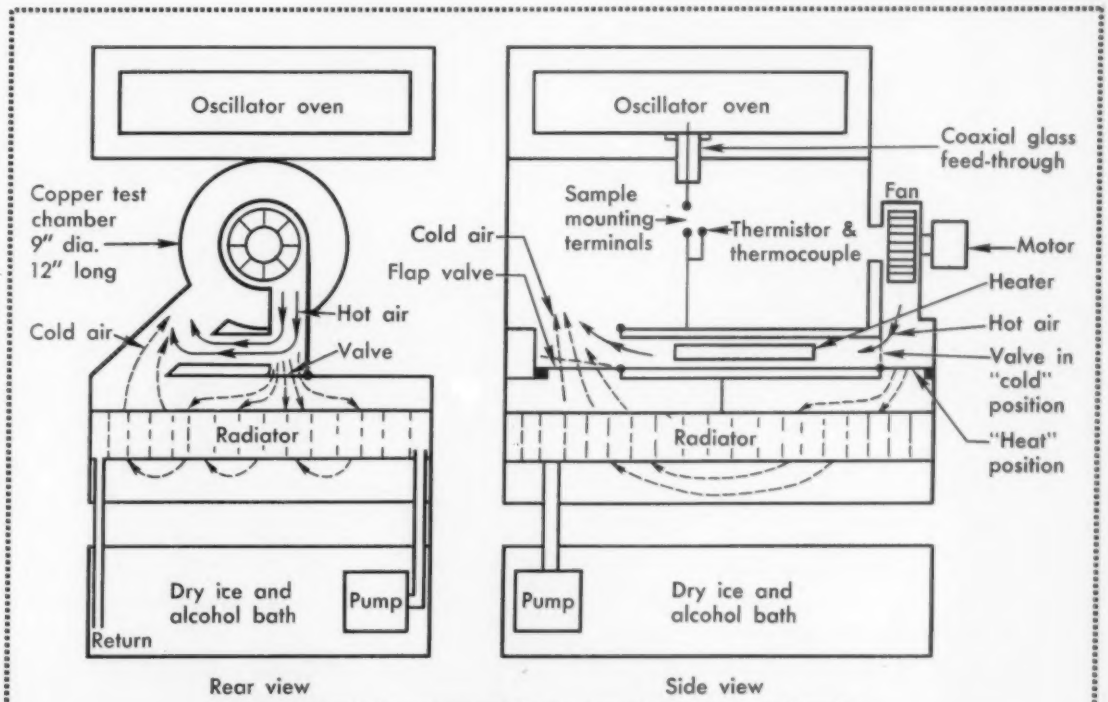

Fig. 6. Detailed arrangement of temperature coefficient test chamber

Graphical method permits checking vhf transistor stability

M. A. GULLEN, P.ENG. & H. H. SCHWARTZ, ASSOC. I.R.E.*

The range of loads, for which a quadripole is potentially unstable, is determined by a simple graphical construction after measurement of three driving-point admittances. The theory is given and illustrated by application to four types of vhf transistor to find the maximum frequency at which each unit will oscillate by reason of its own internal feedback.

In designing a radio-frequency amplifier, the designer must preclude the possiblity of oscillation. The probability of oscillation in any stage is directly related to the gain demanded. The gain, in turn, is related to the load. This paper describes a simple, graphical method by which the range of loads productive of potential instability in a general four-terminal network or quadripole may be determined. The method requires the measurement of three driving-point admittances but does not require measurement of any transfer admittances. The method is applied to four types of transistor, marketed for VHF operation, to find the highest frequency at which each unit will oscillate by reason of its own internal feedback.

In the following the input admittance of the quadripole, output shorted, Y_{11}, is written $a_{11} + jb_{11}$; the output admittance input shorted, Y_{22}, is written $a_{22} + jb_{22}$, etc.; while the product of the forward and reverse short circuit transfer admittances, Y_{21} and Y_{12}, $Y_{12}Y_{21}$ is written Y_t or $a_t + jb_t$. In tube terms, Y_{21} is G_m and Y_{12} corresponds to ωC_{gp}. The bracket term (Y_t) is used to indicate that magnitude only is considered.

The transistor measurements displayed relate to an operating point of 9 volts collector to base and 2.0 milliamps of collector current in a common emitter configuration. Choice of this operating point is governed by the slant to linear ampifier service in the band 4 to 80 Mc where a compromise must be made between dissipation, gain and the avoidance of stage limiting.

The zero input conductance circle

The conductance and susceptance at the input terminals of a quadripole depend on the load at the output terminals. Similarly the output admittance depends on the generator admittance. A previous paper[1] has shown that the loci of constant input conductance and constant input susceptance in the load plane, $a_L + jb_L$, are circles. Two of these circles correspond to zero values. Their radii are given by:

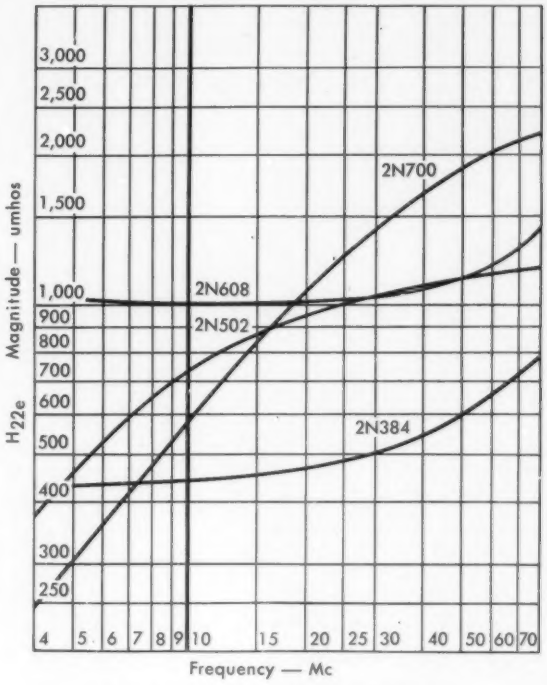

Fig. 1. H_{22e} Magnitude vs. frequency

$$R_{cond\ zero} = \frac{(Y_t)}{2a_{11}}; \quad R_{susc\ zero} = \frac{(Y_t)}{2b_{11}} \tag{1}$$

Two circles will, in general, intersect at two points. The zero input conductance and susceptance circles intersect at:

$$a_L = -a_{22}\ ; \quad b_L = -b_{22} \tag{2}$$

and

$$a_L = \frac{a_{11}\,a_t + b_{11}\,b_t}{(Y_{11})^2} - a_{22} \tag{3}$$

$$b_L = \frac{a_{11}\,b_t - b_{11}\,a_t}{(Y_{11})^2} - b_{22}$$

If these two points and the radii are known an obvious geometrical construction allows the circles to be drawn.

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*Both authors were with the Army Development Establishment, Dept. of National Defence, Ottawa, when this paper was prepared. For further information about the authors, see page 3.

If the quadripole is loaded with an admittance corresponding to a point within the zero input conductance circle the input conductance is negative. If the generator admittance meets certain conditions, the quadripole will oscillate. Confining attention to realistic loads, i.e. loads with positive conductance, the segment of the zero input conductance circle intersecting the load susceptance axis, in the first or fourth quadrants of the load plane, represents a region of potential instability. If a load corresponding to a point outside the zero input conductance circle is chosen, the input conductance is positive, and the quadripole is stable for all generators with positive internal conductance.

The condition that the circle will intersect the load susceptance axis at real points, assuming a_{11} and a_{22} are positive, is

$$2(2a_{11}\,a_{22})a_t + b_t^2 \geqq (2a_{11}\,a_{22})^2 \qquad (4)$$

which is Llewellyn's[2] criterion in admittance form. It is also the condition that the zero output conductance circle will intersect the generator susceptance axis in the generator admittance plane. If a region of potential instability exists in the load plane, another will exist in the generator plane. For analysis purposes it is immaterial which plane is used. Associating instability with the load is the more conventional viewpoint.

Construction of the zero input conductance circle from equations (1), (2) and (3) requires knowledge, for the common emitter configuration, of Y_{11e}, Y_{22e} and Y_{te}. Measurement of Y_{11e} in the range 4 to 80 Mc offers no great difficulty. Y_{22e} is capacitive and ranges from some few tens of micromhos at low frequency to one millimho at the high end. The accuracy of measurement of low admittance, particularly of low conductance, at high frequency with commercial bridges is not high. Under some circumstances it is expedient to use one bridge to measure a_{22e} and another to measure b_{22e}. Real difficulty is met if evaluation of Y_{te} is attempted by measuring the transfer parameters independently. Y_{12e}, the feedback admittance, is small. No commercial bridge will allow accurate measurement over the 4 to 80 Mc range. Alternative methods[3] are not entirely satisfactory. Only the product $Y_{12e}Y_{21e}$ is, however, required. A brief search outside the confines of the admittance parameter set shows a particularly convenient measurement technique.

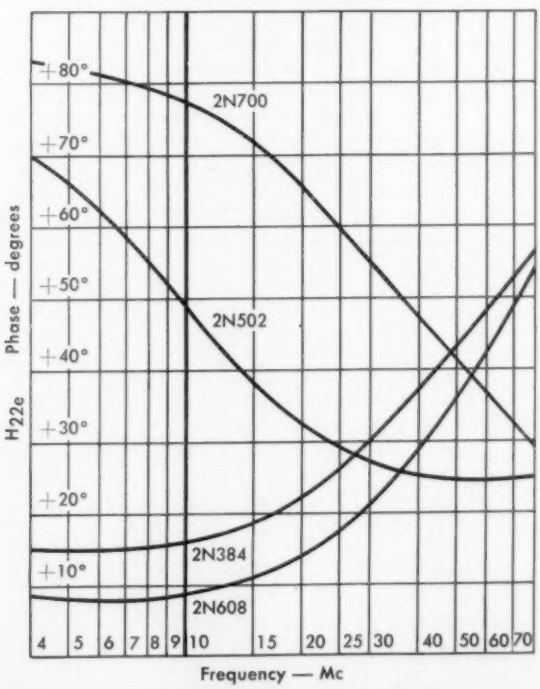


Fig. 2. H_{22e} Phase vs. frequency

The output hybrid parameter

With a finite generator admittance, Y_g, the output admittance of a quadripole is

$$Y_{out} = Y_{22} - \frac{Y_{12}\,Y_{21}}{Y_{11} + Y_g} \qquad (5)$$

The output hybrid parameter, H_{22e}, is, by definition, the output admittance with an open circuit input. Making Y_g zero gives

$$H_{22e} = Y_{22e} - \frac{Y_{te}}{Y_{11e}} \qquad (6)$$

or, rearranging,

$$Y_{te} = Y_{11e}[Y_{22e} - H_{22e}] \qquad (7)$$

(H_{22e}) is greater than (Y_{22e}) and the difficulties associated with measurement of low admittance are reduced. If Y_{12e} is very small, the difference between Y_{22e} and H_{22e} is very small. The inaccuracy associated with the difference of two nearly equal quantities enters. Y_{22e} and H_{22e} may both, however, be measured on the same bridge. The instrument errors will be approximately equal in each case and will tend to cancel in the difference. A perfect open circuit input cannot be obtained. The input will be closed through a small but non-zero admittance Y_o. The correction for Y_o, with the subscript m indicating a measured value, is

$$H_{22e} = H_{22em}\left[1 + \frac{Y_o}{Y_{11e}}\right] - Y_{22e}\frac{Y_o}{Y_{11e}} \qquad (8)$$

If Y_o is small compared to Y_{11e} the correction may be ignored.

The components of H_{22}, $g_{22} + jf_{22}$, may be evaluated in terms of a_{11}, a_{22}, a_t etc. from equation (6). Then

$$g_{22} = a_{22} - \frac{a_{11}\,a_t + b_{11}\,b_t}{(Y_{11})^2};$$

$$f_{22} = b_{22} - \frac{a_{11}\,b_t - b_{11}\,a_t}{(Y_{11})^2} \qquad (9)$$

Comparing this with equation (3), the second point of intersection of the zero input conductance and susceptance circles is

$$a_L = -g_{22}; \quad b_L = -f_{22} \qquad (10)$$

Curves of H_{22e} as a magnitude and angle in the range 4 to 80 Mc are shown in Figures 1 and 2. H_{22e} is, generally, capacitive throughout the range. One sample, a 2N608, has been found which is inductive between 10 and 40 Mc. The 2N384 and the 2N608 exhibit similar trends. The 2N502 and 2N700 likewise exhibit similar trends although the two pairs are markedly different. It is interesting to speculate if the trends evident in 2N384 and 2N608 appear also in

Transistor stability

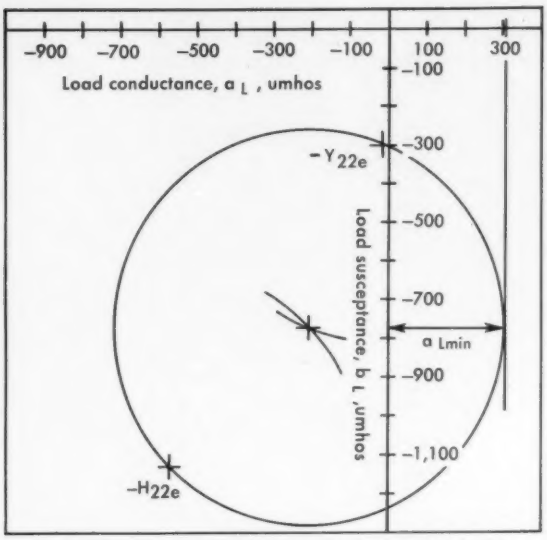


Fig. 3. Zero input conductance circle, 2N700, 25 Mc

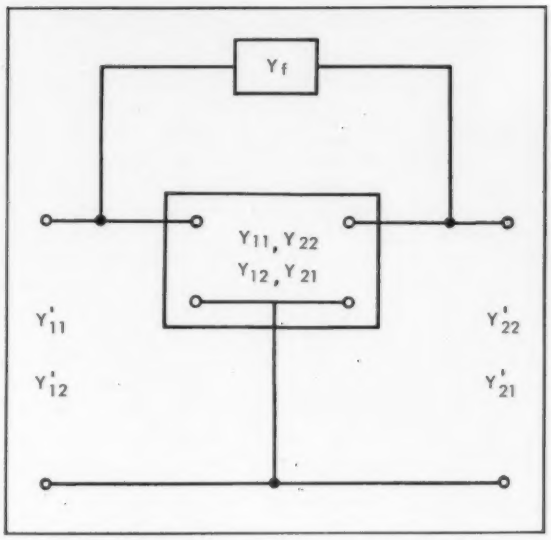


Fig. 5. Quadripole with external feedback

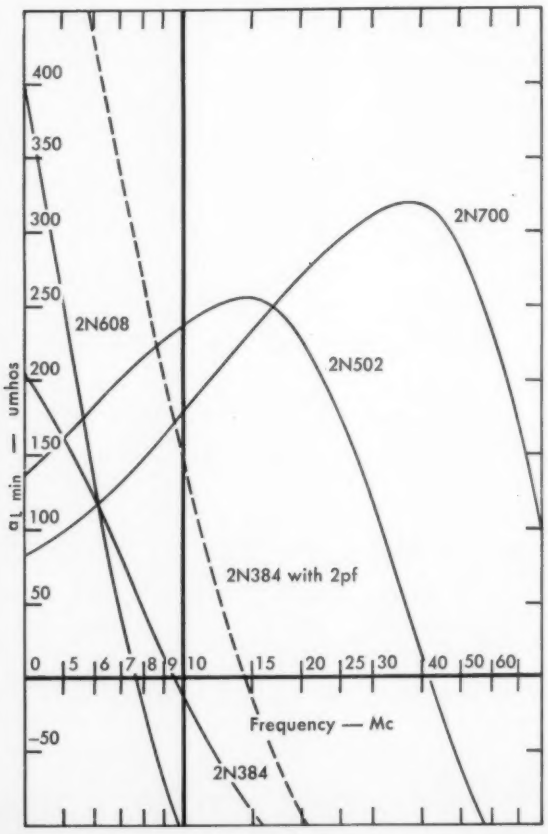


Fig. 4. Minimum load conductance before potential instability vs. frequency

2N502 and 2N700 when the latter are measured above 80 mc.

The minimum safe load conductance, a_{Lmin}

The zero input conductance circle for the 2N700 sample, common emitter, at 25Mc, is shown in Figure 3. The points corresponding to $-Y_{22e}$ and $-H_{22e}$, are plotted. The construction used to draw the circle is indicated. The sample displays a large region of potential instability. The minimum safe load conductance, a_{Lmin} is shown as the tangent to the circle. Any load with a conductance greater than a_{Lmin} cannot give rise to instability. If a_{Lmin} is zero or negative no region of potential instability exists for realistic loads.

An expression for a_{Lmin} is found as the sum of the radius of the zero input conductance circle and the conductance coordinate of its centre.

$$a_{Lmin} = \frac{1}{2a_{11}}\left[(Y_t) + a_t\right] - a_{22} \qquad (11)$$

A plot of a_{Lmin} versus frequency for the four samples is shown in Figure 4. Two additional samples each of 2N384 and 2N608 have been measured. The table shows the frequency at which the a_{Lmin} of each sample falls

Sample	Frequency for zero a_{Lmin}
2N384	9.6, 15.7 & 17.0 Mc
2N502	41.9 Mc
2N608	7.6, 13.5 & 31.0 Mc
2N700	94.0 Mc

to zero. This represents the highest frequency at which the unit will oscillate by reason of its own internal feedback.

External capacitive feedback

When the transistor is included in a circuit, socket and wiring capacities will provide additional feedback between collector and base. This condition is illustrated in Figure 5. Quadripole output is connected to input by a feedback admittance, Y_f. The parameters of the perturbed system are indicated by a prime. It may be shown that

$$Y_{11}^1 = Y_{11} + Y_f \quad ; \quad Y_{22}^1 = Y_{22} + Y_f$$
$$Y_{12}^1 = Y_{12} - Y_f \quad ; \quad Y_{21}^1 = Y_{21} - Y_f \qquad (12)$$

If Y_f is a pure capacity, a_{11}, a_{22}, a_{12} and a_{21} are unchanged. Only the susceptance terms are altered. The effect of this capacity on a_{Lmin} arises from the perturbed values of (Y_t) and a_t. Y_{21e} is some tens of millimhos, and, providing the capacity and the frequency are not too high the perturbation of Y_{21e} is negligible. Then

$$Y_{te}^1 = Y_{te} - Y_{21e}\, Y_f \qquad (13)$$

The three driving-point admittances measured are insufficient to allow calculation of a new value of a_{Lmin} for the perturbed system. Y_{21e} must be known. A standard bridge, available commercially, will measure Y_{21b}, and

$$Y_{21e} = -[Y_{21b} + Y_{22e}] \qquad (14)$$

Generally, external capacitive coupling in a common emitter stage will increase the value of a_{Lmin} and the frequency at which a_{Lmin} falls to zero. An extra 2.0 pf will, for example, change this frequency, in the case a a 2N384 sample, from 9.6 Mc to just over 14 Mc. This is shown by a dashed curve in Figure 4.

One point may be emphasized in conclusion. Choice of a load conductance greater than a_{Lmin} will guarantee stability but sufficient feedback may be present to produce skew bandpass characteristics, and make a tuning operation difficult in a narrow band, distributed selectivity amplifier. Neutralization may still be required.

Acknowledgement

The authors wish to acknowledge the assistance of Mr. H. O. Hansen whose many measurements made possible the figures of this paper. END

REFERENCES:

1. M. A. Gullen, "The transistor as a 4-terminal network," Canadian Electronics Engineering, Vol. 3, No. 4, page 25, April, 1959.

2. Llewellyn, "Some fundamental properties of transmission systems," Proc. IRE, Vol. 40, page 271, March, 1952.

3. O'Connell and Scott, "Measurement of transistor characteristics," RCA Review, Vol. 19, No. 4, December, 1958.

Temperature coefficient measurement — continued

tion occurs on the component. This can introduce considerable error. One complete cycle takes from one to two hours depending largely on the rate at which the sample stabilizes.

Mounting samples

Mounting of the sample in the chamber must be given careful consideration. The leads must be so arranged that any small movement of them will result in only a very slight change in capacitance. For this reason the samples are connected between the feedthrough and the ground strap in such a way that the leads do not run parallel to each other. This is illustrated in Fig. 5.

Sensitivity and accuracy

The resonant circuit as shown in Fig. 1 consists of an L_0 of 0.39 mh and a total C of 65 pf. The minimum to which C can be reduced due to the limits imposed by C_2, C_4 and the minimum of C_3, is 55 pf. This arrangement is therefore suitable for evaluating capacitors up to 10 pf and represents the maximum sensitivity attainable with this particular circuit. For higher values of C, L_0 must of course be reduced to an appropriate value to maintain resonance at 1 Mc.

To illustrate the accuracy of the system, consider the effect that a 10 pf capacitor with a TC of -30 ppm/deg C will have on the frequency as the temperature is changed from $+25$ to $+85$ C. Equation 2 indicates that a Δt of 60 C produces a Δf of 193 cps.

The oscillator has a stability of ± 1 cycle over a period of eight hours; this is considered satisfactory since the time required for one complete temperature cycle is generally less than two hours. The frequency counter has an accuracy of ± 1 cps, and the drift of the oscillator due to temperature cycling is also in the order of ± 1 cps. Assuming that all of these errors are in the same direction and that the temperature increment measured is in error by 0.5 C, so that $\Delta f = 190$ and $\Delta t = 60.5$ C, the TC becomes 29.3 ppm/deg C. This represents an error of only 0.7 ppm/deg C.

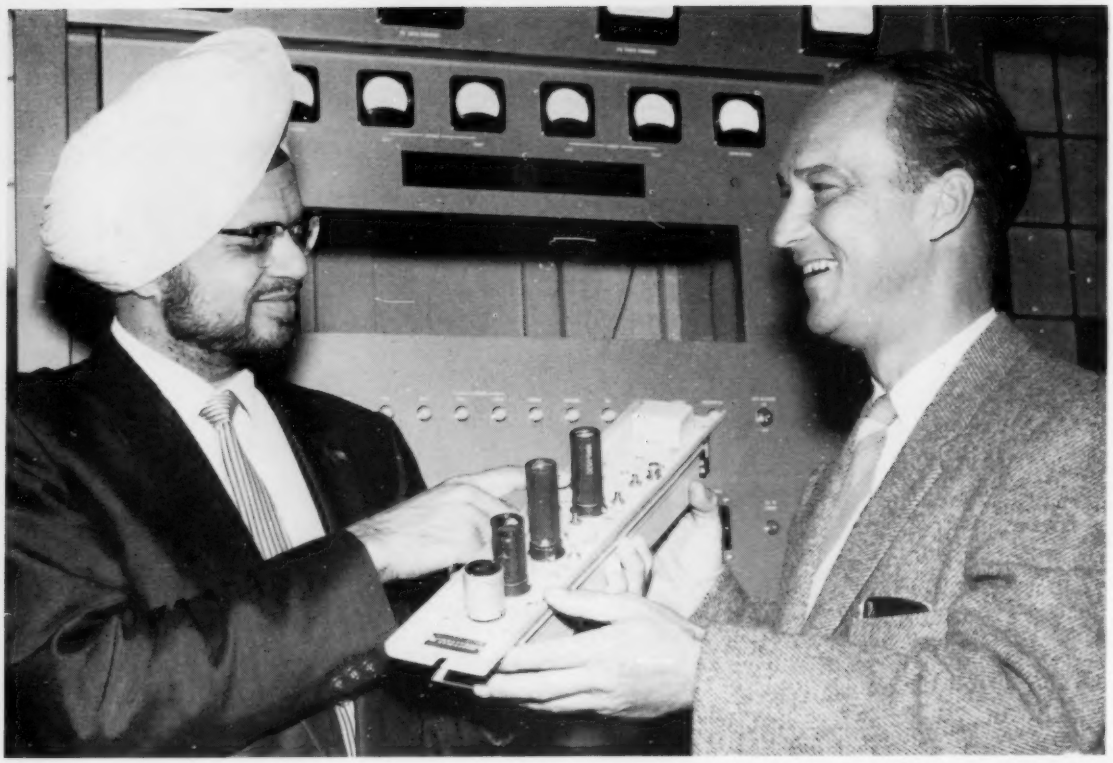
Conclusion

This test set-up has been used for some time now and has been found satisfactory for laboratory use. Its chief shortcoming is that it can only test one component at a time.

Acknowledgment

The authors wish to express their appreciation to Mr. D. A. Bova who was instrumental in the construction of the equipment and for his helpful suggestions. END

What's new in view



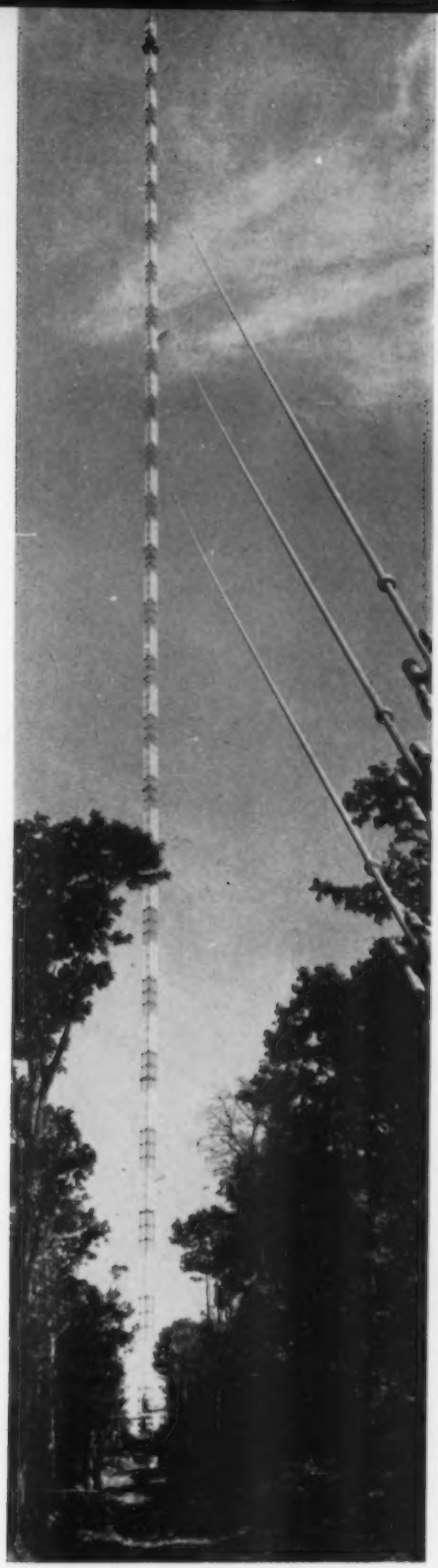
Radio Malaya is planning a TV network and sent its chief engineer, Kirpal Singh Gill to Canada to study our system. While in Toronto he visited J. R. Warren to see broadcast equipment manufactured at Canadian General Electric Co. Ltd.

Dr. W. DeSorbo, GE Research Laboratory has developed a technique for visual observation of superconductivity. Dark areas on thin sheet of tantalum are superconducting.

Missile component test boom resembles a ferris wheel as it revolves on the radar range at the Engineering and Research Centre of Ford Motor Co.'s Aeronutronic Div.

Group of Canadian companies (Hunting Survey; McElhaney and Nelson Ltd.; Canadian Aero Service) helping to map the Mekong River in Laos and Cambodia hired this local technician to service their Tellurometer equipment.

This "robote" inspection unit for telephone handsets has been developed by the National Telecommunications Research Centre, Paris, to inspect transmitter capsules.



Tallest man-made structure, WGAN-TV's 1,619-ft. antenna in Raymond, Maine, is linked to studio with Raytheon KTR-1000G relay.

Electronic developments featured at Instrument Society meeting

Electronics played a major role in the 15th annual conference and exhibit of the Instrument Society of America, held in New York City, September 26-30. Both technical sessions and exhibits appeared to be predominantly electronic in nature, emphasizing the important trend which this industry has created in the field of instrumentation.

The conference was opened officially by a tiny space craft instrument beaming heart beats. Strapped close to the heart of an officer of the U. S. Navy, the device, a highly efficient transducer-FM transmitter, detected heart beats and telemetered them to a receiver in the main lobby of the Coliseum for the opening ceremonies.

The interest which U. S. armed services have in instrumentation was demonstrated by a group of exhibits devoted primarily to space flight and aviation medicine. The interest was also explained at a press conference by Major General Earle F. Cook, Deputy Chief Signal Officer, Department of the Army:

"The Army, and particularly the Signal Corps, is especially involved in electronics, thermionics, nucleonics, sonics, photometry and meteorology. Our laboratory necessarily works in the study of matter and materials, in the physics of the atmosphere, the troposphere and the ionosphere—and now in the physics of space — and in all of the related scientific areas where instrumentation plays such an essential role that we would be helpless without it.

"The U. S. Army Signal Missile Support Agency at the White Sands Missile Range in New Mexico provides one example of the scope of interest in instrumentation. Established in 1945, the Army Signal facility is currently valued at approximately ninety-three million dollars."

Major General Cook went on to describe other areas where instrumentation is vital: avionics, radio wave propagation research, meteorology, satellite programs, telephone communications, and many others.

Oil industry needs new instruments

In an address at the keynote session, E. D. Reeves, vice-president and director of Humble Oil & Refining Co. said that the oil industry leads the nation in capital investment — $64,000 per employee compared to about $15,000 for industry in general — but there still is great need for further instrumentation if it is to achieve the progress necessary to the U. S. economy.

Mr. Reeve said that "the goal of our refineries is full-fledged automatic control, and what we would like to see is a system of instruments and computers into which we could feed market requirements.

"From there on the computers would calculate the materials that would be required and send signals to individual processing units as to what they should do to make these products in the most economical fashion. Each unit would then follow instructions through its own system of continuous analyzers, sensing mechanisms, computers, and feedback control units."

Further information on process computers was given in a paper by Dr. Thomas J. Glass and Tsai H. Lee, Computer Department, General Electric Company.

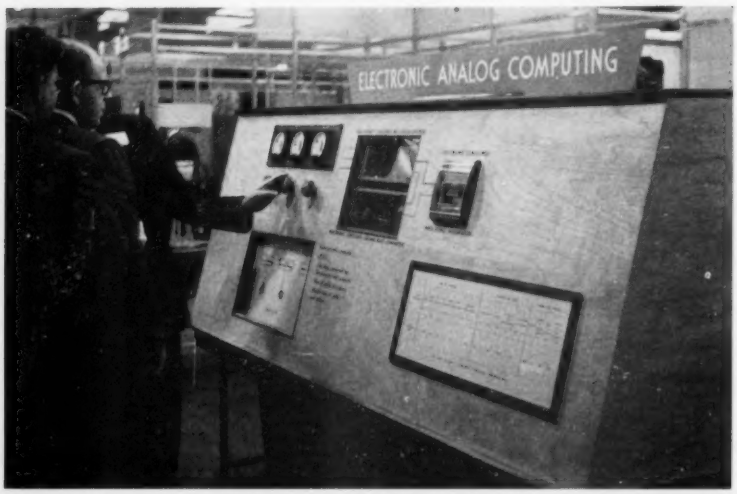
"Through a critical evaluation of the actual capabilities and benefits of existing applications, a philosophy has been developed which gives the on-line process computers a unique place among the various devices used for process operation. In contrast to conventional instrument controllers and business computers, process computers can best perform functions involving 10-1,000 variables in time scale of seconds, minutes and hours. This philosophy can also be used to determine whether any given function under consideration should be implemented in instrument - controllers, process computers, or other types of computers."

Oceanographic instrumentation

Six sessions on underwater instrumentation were held during the ISA conference to discuss electronic equipment designed to measure temperature, pressure, sound velocity and other important quantities. In his paper "State of the Art", Roy L. Rather, president, Commercial Engineering Corp., Houston, Texas, describes the main problems in designing and selling instruments for oceanography. To begin with, there are limited funds for this work, and few people engaged in it in North America. Many oceanographers feel that less time is spent and with greater assurance of ultimate success if they just take time out to build their own equipment. It is difficult to convey ideas to commercial instrument designers, since few of them have had any experience in oceanography.

In many respects, sea-going scientists labor under several disadvantages. Most of the ships used are small and in this harsh environment the oceanographer must be as much seaman as scientist. His instruments tend to be rugged and crude with attendant loss of precision and flexibility.

However, Mr. Rather predicted that the market for instruments in oceanography will expand with the increasing recognition of the importance of this science.



Analog computers are rousing keen interest among instrumentation people. This electronic demonstration model was located in the Foxboro Co. booth.

Speaking from the other side of the fence, Roy D. Gaul, physical oceanographer, and J. J. Schule, Jr., U. S. Navy Hydrographic Office, in a paper "Oceanographic Requirements versus Instrumentation Capabilities," shared many of Mr. Rather's views. They pointed out that many of the platforms, techniques, instruments and analysis procedures are the same as those used 50 years ago.

Oceanographers have shown little interest in a "systems" concept of research. Instead, they have tended to investigate one problem at a time. That has lead to incompatibility of instruments and techniques among oceanographers and has hindered any attempt to analyze information through modern data processing equipment.

Theme of the ISA conference was "Progress through instrumentation", but this slogan in Fischer & Porter booth was more accurate description of exhibits.

G. Farrel, Jr., Lockheed Missiles and Space Div., discussing instrumentation for Bathyscaphe Trieste.

Report from Moscow

One highlight of the conference was a session in which nine American scientists reported their observations on the First Congress of the International Federation of Automatic Control, held in Moscow earlier this year.

In a sense, the session was a disappointment. Instead of providing the significant news from the congress, some of the speakers devoted their time to listing the subjects covered in the congress papers. Perhaps it was done because they couldn't form any over-all opinions about the meetings—a problem of high magnitude where 11 simultaneous sessions were held.

Despite this, some interesting and significant opinions were expressed by panel members. Most of the work described in U.S.S.R. papers appeared to be at least one year old at the time of the congress, making it difficult to assess the present status of projects.

The Russians have done a great deal of work in self-optimizing and adaptive control systems, but many of the research projects are devoted to outdated problems because research in U.S.S.R. is directed by older people.

Research in automatic control in U.S.S.R. appears to be more extensive than in U.S.A., but it is applied primarily to the control of steel mills with little attention to process industries. The opposite is true in the United States.

One U. S. delegate visited some steel mills and found no evidence of automatic control equipment. However, he concluded that equipment described in the Russian papers did exist, but in plants not visited by the Americans. His belief was based on the quality of equipment, such as guns and trucks, which they did see.

American delegates were unanimous about one point. Most U.S.S.R. scientists are much better informed than are their American counterparts. This applied to work carried out in both countries and published in both languages.

Canadian high altitude research

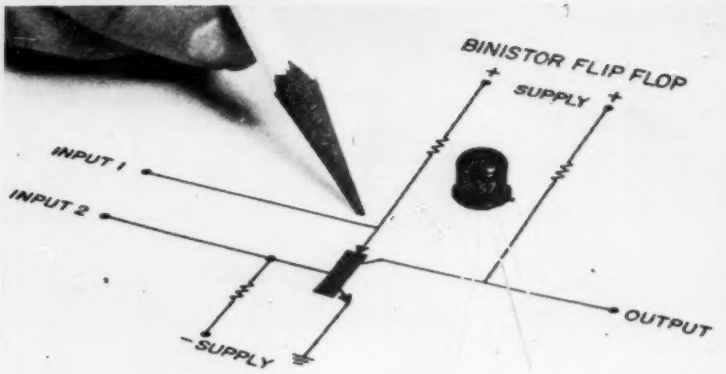
At a symposium sponsored by the Canadian Aeronautical Institute in Ottawa last month, scientists outlined recent developments in Canada's high-altitude research program. In the opening paper Dr. D. C. Rose, National Research Council, pointed out that Canadian activity in space science is essentially an outgrowth of our interest in the upper atmosphere and the interaction of the solar atmosphere with the earth's magnetic field. New techniques made available by the use of sounding rockets and satellites are having a profound effect on the advance of knowledge of the environment of the earth. Canada has a particular interest because of the location of the north magnetic pole.

Scientists from the Cosmic Ray Section of NRC have carried out a rocket program in the summers of 1959 and 1960 to study the particles responsible for, or associated with polar cap absorption events. Dr. I. B. McDiarmid described the work and then went on to discuss plans for a proposed cosmic ray satellite experiment to study background cosmic radiation and particle intensity changes associated with solar and geophysical phenomena.

The Institute of Upper Atmospheric Physics, University of Saskatchewan, plans to eject two or more spherical packages from a rocket near the top of its trajectory to study electron density profiles for two or more separate paths through the ionosphere. Each package is instrumented to measure electron density during free fall by means of direct measurement of the local plasma frequency.

Techniques for direct measurement of pressure, density and temperature in the upper atmosphere are under development at the Institute of Aerophysics, University of Toronto. Tests of methods for the determination of low pressure at high speeds in the laboratory have been successful and instruments are now being prepared for rocket experiments. Feasibility studies are in progress on the use of an electron gun as a density probe in the upper atmosphere and laboratory tests show that this device will give accurate measurements of both density and temperature.

New components



Silicon semiconductor switching device 101

Transitron Electronic Corp. has developed a new silicon semiconductor switching device called the binistor for use in switching and storage circuits. It is a bistable device which retains its properties over a wide range of ambient and bias conditions. It employs a new mode of operation for bistable devices and is compatible with present circuitry. Comparing the binistor with a typical flip flop, the latter employs two transistors, seven resistors, two capacitors, two diodes and 28 solder connections. A binistor stage reduces this total to only one binistor, three resistors and 10 solder connections. In structure the silicon NPN tetrode binistor resembles a four layer switch. However, the output current is taken from an intermediate layer and the upper junction serves only as a latch, rather than a lock to hold the device on when in the conducting state. The speed is slower than high frequency transistors, but new models of the binistor are being developed for higher frequency and power operation.

Transitron Electronic Sales Corp., Toronto.

Field mesh image orthicon 102

Field mesh image orthicon type GL-7293 minimizes portholing and edge-effect to produce a better picture than previous image orthicons. The electrical effect of the field mesh is to improve beam landing by creating a more uniform electric field in back of the target. GL-7293 is interchangeable, electrically and physically, with the 5820, but differs slightly in construction and operation.

Canadian General Electric Co. Ltd., Toronto.

Pressure sensitive adhesive 103

SF-17, a new pressure sensitive adhesive backing, holds parts to components during assembly in blind spots or hard-to-reach areas. Often, no other fastening is required since SF-17 permits adherence to almost any solid surface. It can be furnished on Spaulding's vulcanized fibre in sheets of 1/32 in. thickness or more, as well as on Spauldite.

Spaulding Fibre of Canada Ltd., Toronto.

Reed relays 104

These new reed relays incorporate a short pole piece with a longer moving reed, permitting higher operating speeds with less contact bounce. A hermetically sealed, glass encapsulated magnetic reed switch is surrounded by an operating coil to provide spst, normally-open relay action. It is suitable for low level switching or for low power switching of loads up to 15 watts and 250 volts. Maximum operating current is 1 ampere. Load life at ¼ of maximum rating is of the order of 200 million operations.

Struthers-Dunn Relays, Toronto.

Chassis slides 105

Six types of chassis slides are available in three sizes of each type. The SI models are for industrial and military use with MIL specs. The SC models are designed for commercial applications. All accommodate 17-inch chassis. Quick detach and tilting models may be obtained.

Bud Radio, Inc., Cleveland.

Reflex oscillator 106

This new microwave reflex oscillator, a retarding field oscillator, eliminates the r-f grids found in other types of reflex tube. This results in increased efficiency, with efficiencies of 3 to 4% at X band attained in early studies. In the RFO, electrons pass through only one ungridded aperture instead of three gridded apertures as in conventional reflex oscillators. Losses are lowered and a greater percentage of cathode current is available to deliver power to the load. The present design delivers one watt output at X band.

Sperry Gyroscope Co. of Canada Ltd., Montreal.

(Continued on page 60)

New instruments

Frequency monitor 107

Airpax series 4000 frequency monitors indicate the frequency of a 400 cps source with an accuracy of 0.01%. Cabinet, portable and rack-mounted versions have 4½ in., 50 ua meter movements and anti-parallax mirror scales. Indicating meters have three scale calibrations, each with 400 cps centre reading: 375-425 cps, 395-405 cps and 399-401 cps. These frequency monitors will drive recorders having an impedance of approximately 500,000 ohms. Power is 60 cps or battery.

Leonard Electric Ltd., Toronto.

Dynamic beta transistor tester 108

Collector current and collector voltage can be varied in Model 870 transistor tester to provide proper conditions for correct beta measurements. It measures large signal dc beta on power transistors us well as small signal ac beta on low and medium power transistors. Collector

test current is variable up to 2 amperes, permitting beta measurements of power transistors rated 5 amperes and more. The new tester has three Icbo ranges: 0-100 ua, 0-1 ma and 0-10 ma. Two beta ranges, 0-100 and 0-300, are incorporated together with a feature that permits half-calibration effectively increasing the upper beta range to 600.

Stark Electronic Instruments Ltd., Ajax, Ont.

32-channel oscillograph 109

Hathaway model ES-9 Thirty oscillograph records up to 32 independent channels of analogue information. Within the recorder's case, up to four initiating relays may be housed, to automatically start the recorder on such faults as low line voltage, overvoltage, neutral current flow, overcurrent. Upon detection of a fault, the recorder chart is brought up to speed within a fifth of a second. Normal speeds are three and twelve inches per second. A variety of galvanometers is available for different applications.

B. H. McGregor, Toronto.

Oscilloscope 110

Operating with low-cost signal-amplifier and time-base plug-in modules, the Type 561 offers the type and degree

New equipment

of performance demanded for a particular application. Basically an indicator unit, the Type 561 contains a 5-inch crt with 3.5 kv accelerating potential, an 8 x 10 cm viewing area, an amplitude and sweep-time calibrator, and power supply capable of handling additional contemplated plug-in modules. The indicator unit powers any two of the five presently available modules — which drive the crt deflection plates directly.

Tektronix, Inc., Willowdale, Ont.

Mark generators 111

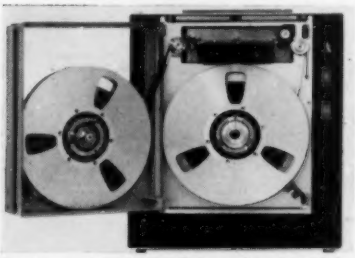
Crystal controlled marker generators, Models CM-6 and CM-10 use harmonic and side band techniques to attain many more marking indications than would be possible directly from the 6 and 10 crystal oscillators which they contain. Utilizing a single centre frequency oscillator it is possible to choose two side band oscillator frequencies to provde a total of five marks, one at the centre frequency, two at the band edges and two at the 3 db down points.

CM-6 is a six-crystal unit housed in a portable cabinet and the CM-10 is a 10-crystal unit for rack mounting. Output amplitude of each oscillator is individually controlled. The generators are also equipped to provide dc marker indications. A 40 db variable gain oscilloscope preamplifier is provided to facilitate response measurements of higher attenuation devices. In addition, provision is made to switch in a high pass audio filter to improve the sensitivity and display of wide band VSWR measurements.

Jerrold Electronics Corp., Toronto.

Tape recorder 112

Precision Instrument Co. instrumentation magnetic tape recorder, named the pi recorder reproducer, provides a frequency response from 50 to 200,000 cps at a tape speed of 60 inches per second for direct recording, with comparable response at lower speeds. For f-m recording, frequency response is 0-20 kc at 60 inches per second, using standard 40% deviation for full scale signal.



Reel-to-reel and continuous loop models are available, with head spacing and track width conforming to IRIG standards, in 2, 4, 7, and 14-track configurations at all standard tape speeds.

R-O-R Associates Ltd., Don Mills, Ont.

(Continued on page 64)

Two-way radio 113

This 100-watt transistorized two-way, mobile radio operates in the low band frequencies, 25 to 50 mc. Case size is only four inches high, 8⅝ inches wide and 15 inches long, permitting it to be mounted under the dashboard in most cars and trucks. However, the unit is designed in two sections to facilitate other mounting arrangements. It draws only 1.75 amperes when "on" ready to transmit. Standby drain is only 40 ma using a 2-watt speaker. A 30-watt unit in low band will also be made available.

Canadian General Electric Co. Ltd., Toronto.

Converter for recorder 114

A new two-channel ac to dc converter, type A-1, enables ac voltages to be plotted on Mosley Autograf X-Y recorders. The circuit consists of a two stage amplifier and a full wave rectifier, a portion of the output current being fed back to the input stage to linearize the diode characteristics. Input is single ended, and output is differential. The output signal is proportional to the average value of input signal. Voltage ranges are calibrated in rms for a sinusoidal input. Frequency range of the converter is 20 cps to 100 kc. Voltage ranges are 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 volts per inch (based on use with Autograf recorders).

R.O.R. Associates Ltd., Don Mills, Ont. and ARVA, Vancouver.

Contact tools 115

Simplified insertion and removal tools have been developed for use with Deutsch DS snap-in contact connectors. The tips, when damaged or worn, can be removed and replaced at a fraction of the original tool cost. The insertion tool inserts and locks the contact in a positive alignment position, then slips back out of the hole free of the contact wire. The removal tool relaxes the contact retention spring and pushes the contact toward the rear of the connector for easy removal.

Brian Engineering Ltd., Montreal.

Motor starting equipment 116

Static Slipsyn field panels are designed for application on low and high voltage synchronous motor starting equipment. The circuitry employs static components to perform complex logic operations including: application of motor-field excitation at both proper speed and most favorable rotor and stator relationship; detection and removal of excitation if the motor pulls out of synchronization. Control elements require no dc supply as a small transformer energized from one phase of the ac supply provides all the power required by transistor circuits. Use of the new panels will enable the motor field to be applied accurately from 90 to 99% of speed.

Canadian Westinghouse Co. Ltd., Hamilton.

Microwave modulator 117

Narda model 10003 microwave modulator has been designed for operation with beacon type magnetrons such as are used in navigational radar. It contains an internal generator which provides a pulse width from 200 to 4,000 pps; pulse voltage from 0 to 5 kv; and pulse current of 2 amps maximum. Pulse repetition rate is continuously variable over the range from 0.4 to 2.2 usec. Safety features include automatic sequencing circuit, overload sensing circuits and discharge circuits.

MEL Sales Ltd., Toronto.

(Continued on page 66)

Reports — continued

BBG to hear applications for second tv network

The Board of Broadcast Governors will hold a public hearing in Ottawa on November 29 at which any applications for a second television network will be heard. Following earlier hearings, amendments to the Radio (TV) Broadcasting Regulations regarding networks were published in the Canada Gazette on October 26.

New representatives and principals

Harmon-Kardon, Inc., Plainview, L.I., N.Y. have appointed **Chas. W. Pointon Ltd.,** Rexdale, Ont., as Canadian sales representative (high fidelity amplifiers, am-fm tuners, Citation high fidelity kits).

Desser E-E Ltd., Montreal are now the electronic and electrical sales representative for Canada for Kulka Electric Corp., Mount Vernon, N.Y. (terminal blocks, switches, wiring accessories).

New sales company formed

A new company has been established to act as a sales outlet for the products of Canadian Atlas Transformer Co. Ltd. (all types of transformers to 35 kva) and Rotronic Corp. Ltd. (electronic and electromechanical components), both of Toronto.

The new firm, **Pyrel Limited,** is located at 12 Duchess St., Toronto 2 (telephone EMpire 2-3748). It will also distribute British G.E.C. tubes in Ontario, including the well-known KT66 and KT88, thyratrons, klystrons, etc.

Companies on the move

Daystrom Ltd., Canadian affiliate of Daystrom Inc. (Heath Co., Weston Instruments, etc.) has moved to a larger, more modern building at 1480 Dundas Hwy. East, Cooksville, Ont. New telephone number is ATwater 9-3191.

Honeywell Controls Ltd., Toronto announces that its Vancouver sales office has been moved from 1128 Burrard St. to 1390 East 4th Ave., Vancouver 12. New telephone number is ALpine 5-6511.

Whittaker Electronics Ltd., sales representatives, have moved to 1171 Whitmore Ave., Ottawa 3. Tel.: PA 2-8563.

Ottawa Report—contd.

much more protracted negotiations which resulted in the establishment of quotas on various textile products, such as spun-rayon, last year.

Government officials said negotiations to set next year's quotas will begin immediately but could give no firm indication what form they will take.

However, it is understood the government is pressing for a repeat of the quota system on Japanese textile products: an annual increase of 5 to 10% on the condition the domestic industry has enjoyed a "good" year.

Reports here are that the greatest influx of Japanese tubes has been in the first two weeks of October just before the ban was imposed. Some 300,000 tubes are believed to have been consigned in that two-week period.

It's a case of locking the door **before** the horse has bolted in the government's move to place magnets for use in the manufacture of loudspeakers in the category of a class or kind made in Canada.

Officials of the Revenue Department said the magnets, previously classed as not made in Canada, will continue to come in duty free. However, they are now eligible for special duties under the anti-dumping provisions.

Bulk of imported loudspeaker magnets come from the United States and Britain. There are no reports of any dumped on the Canadian market, but this action will provide protection if it becomes necessary. The magnets are manufactured in Canada by Indiana Steel Corp. of Kitchener and General Electric of Quebec City. The move was made at their request.

Do you want the facts about selling to the biggest buyer in the country? Then write to the Small Business Branch, Trade Department, for a copy of its manual on selling to the federal government.

The federal government goes to the market every year for some $1.4 billion worth of goods and services. Due to be published before the end of this year is a 70-page manual on how government buys and what it buys.

A dozen of the major purchasing departments, such as Defence Production and Public Printing and Stationary, are described in detail, their purchasing agents listed and some 600 of their main requirements tabulated.

AVAILABLE NOW

The new MODEL '270'

A custom instrument in the Simpson "260" tradition

- Increased accuracy
- Human engineered scales
- Movement overload protection - and a host of other attractive features for discriminating users.

For those who for years have valued the reliability and versatility of the Simpson "260", the Custom-Engineered Model 270 offers a multitude of new features for applications calling for a higher order of accuracy, with no sacrifice in the qualities which have made the "260" famous the world over.

Ranges and scale layouts have been designed for maximum readability with an anti-parallax mirror and knife edge pointer. Precision components and calibration techniques assure accuracies down to ± 1.25% on most of the D.C. ranges, with similar accuracy improvements on other ranges. In addition, the operating manual specifies accuracies on all ranges for a variety of operating conditions, frequency correction curves and a host of useful information.

To conserve this high order of accuracy, a circuit fuse and meter current-limiting diode guard against accidental overload, over and above that provided for in the choice of rugged and generously rated components.

Truly a Custom-Engineered Instrument to suit the present day trend to greater precision in measurement.

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Electronic music—continued

to cause them to leave in droves!

Another work, by Berio, was based on a passage from James Joyce's "Ulysses" and did little but prove that in its present stage, electronic music shares with the more extreme forms of modern art and poetry the complexities and obscurities which puzzle the simple mind. But perhaps in time, some of these may be resolved into something more worthwhile and generally acceptable. As an after-dinner speaker once said, they are entering virgin fields, pregnant with possibilities!

As electronic engineers, we shall watch their endeavors, perhaps with some concern, but with very great interest. END

Power divider—continued

The power divider may be adjusted so as to provide peak isolation at any frequency within the design frequency band; however, as illustrated in Figure 4, it is not always possible to obtain peak isolation at the same frequency from both output ports with the same adjustment. This is due to slight variations of the junction properties from ideal operation. It is, however, possible to achieve isolations of the order of 30 db (only 0.1% of input power reaching unwanted port) over a bandwidth of about 10% of the centre frequency.

Power division is illustrated graphically by the complementary curves of Figure 5. These curves show the power level in each of the output ports as a function of slab position.

Reflections into Port 4, which do not exceed 0.2% of the input power for frequencies between 2,700 and 3,000 mc, increase to approximately 2% at 2,600 mc. For most purposes this amount of power may be neglected.

Since all components of the system are capable of withstanding high peak power levels, the device is useful in applications involving such levels. As an example of power handling ability, no evidence of power breakdown was observed in the S-band unit at 500 kw peak power level.

Applications

As a power divider, this device is potentially useful in diversity systems where it is desired to be able to vary the power fed to two antennas which are separated in space, oriented in different directions, or which have different characteristics, e.g. orthogonal polarizations or different beamwidths.

If a high-power dissipative load is connected to one of the output ports, the device is useful as a high-power attenuator in which the amount of power available from the remaining port is continuously variable. It has the advantage that no power is dissipated in the moving parts of the system.

Although the data presented here refer specifically to S-band, similar results should be obtainable in other microwave bands for which hybrid junctions are available. END

REFERENCES

1. W. L. Teeter and K. R. Bushore, "A Variable-Ratio Microwave Power Divider and Multiplexer," Trans. I.R.E., vol. MTT-5, pp. 227-229; October, 1957.

2. H. J. Riblet, "The Short-Slot Hybrid Junction," Proc. I.R.E., vol. 40, pp. 180-184; February, 1952.

3. G. L. Raglan, "Microwave Transmission Circuits," McGraw-Hill Book Company, Inc., New York, New York, pp. 514-516; 1948.

The AMPEX FR-100B is a high performance instrumentation magnetic tape recorder suitable for a wide variety of industrial and scientific applications. In manufacturing it is used extensively in both machine tool and process programming. In research it will record such diverse things as the thrust measurements of a jet engine, cosmic ray counts from a satellite, or vibration data developed in testing a new car body. This information can be recorded by direct techniques, on an FM carrier, by pulse duration modulation, or through NRZ digital techniques. It is capable of recording up to 14 analog or 16 digital tracks, operates at any of 6 standard speeds from 1⅞ to 60 inches per second... can be modified for other speed combinations. And, depending on the system used, it will record from a direct current signal up to 100 kilocycles, ±3 db. The FR-100B will also reproduce tapes it has recorded, or those made on similar Ampex machines. I.R.I.G. compatible at no extra cost. For complete information on this remarkable recorder write to Ampex of Canada Ltd., 607 Commonwealth Bldg., Ottawa, Ontario AMPEX

For further information mark No. 12 on Readers' Service Card

For your library

Conference proceedings provide recent data on thermoelectricity

Thermoelectricity

Edited by Paul H. Egli; John Wiley & Sons, Inc., New York; 407 pp; $10.00.

Reviewed by E. L. R. Webb, Senior Research Officer, Radio & Electrical Engineering Div., National Research Council, Ottawa.

The complete title "Thermoelectricity, including the Proceedings of the Conference on Thermoelectricity, sponsored by the Naval Research Laboratory, September 1958" together with the significant words "edited by" tells us at once that here is yet another in the current crop of books on thermoelectricity that are in reality collections of papers by a host of authors.

The obvious advantages in publishing this kind of book are that it is easy, it helps speed up the dissemination of ideas and aids people with limited library facilities to accumulate reference material. Unfortunately there are usually some disadvantages, especially to the reader. In this case there are the inevitable discontinuities in style and points of view from chapter to chapter. There also tends to be some overlapping between chapters but this is not necessarily a bad thing in a new subject.

So much has already been written in defense of both current rebirth of interest in thermoelectricity, both for the device applications, i.e. refrigeration and power generation, as well as for the opportunities it provides for exploring the basic properties of matter, that little further need be said as to why the present book is timely and useful, which indeed it is.

The book as a whole naturally conforms with the theme of the Conference, which was to provide guidance to the program supported by the U. S. Navy to develop the thermoelectric art. This is perhaps most evident in the transitional remarks between sections and the final chapter written by the editor.

The contributed chapters have been grouped under four sectional headings:

I. Fundamental Concepts in Thermoelectricity
II. Basic Parameters in Thermoelectricity
III. Chemical and Physical Properties of Materials at High Temperatures
IV. Measurement of Material Properties

but the division between I and II appears somewhat artificial being more one of degree rather than kind. Together these sections make up about 40% of the book.

The third, rather short, section pursues the all-important subject of material properties, which in the final analysis form the basis for any practical application. Here considerable emphasis is placed on high temperatures, which are mandatory for high over-all efficiency.

The fourth, and longest, section is on measurements and again the emphasis is on high temperatures. This section reflects the concern over the state of the art a few years ago when discovery was far outstripping technique. In this connection it should be pointed out that the present volume is not the only publication that has resulted from the NRL program. For

almost two years now NRL has been issuing a series of very useful Status Reports on Thermoelectricity.

In conclusion it may be said that the book will be a useful reference for established workers in thermoelectricity. It is not, nor was intended to be, a good introduction to the subject.

Electric Circuit Theory

F. A. Benson and D. Harrison; Edward Arnold (Publishers) Ltd. (The Macmillan Co. of Canada Ltd., Toronto); 371 pp; $5.00

Reviewed by H. C. Ratz, Computer and Control Systems Laboratory, University of Saskatchewan, Saskatoon.

Topics in both power and communication circuit theory are covered in this undergraduate text. A first course in electricity and magnetism and elementary calculus are assumed. This is an intermediate text emphasizing basic circuit theory as applied over a wide field. The treatment of individual topics, therefore, is introductory rather than detailed.

The book begins with a short review of fundamental electrical quantities and the use of basic network theorems in dc circuits. This is followed by single phase and polyphase ac circuits. The use of complex numbers to describe vectors and their application to ac circuits are fully developed. Next comes the general principles of ac network analysis with additional attention given to coupled circuits and transformers. The applications in power networks are concluded with unbalanced three phase circuits and symmetrical components. A good introduction to transients is followed by two chapters on common vacuum tube and communication circuits.

Because of the wide field covered, the treatment is necessarily insufficient for the final years of an university Electrical Engineering Course. Rather than using such a broad introduction, some may prefer to cover basic portions more completely and postpone the advanced applications to the senior year. The authors have produced a concise and sufficiently well-written book to encourage self-study by correspondence or technical institute students. And answers are included with the problems at the end of each chapter.

Publishers' new releases

Physics of Semiconductors

This is an English translation of the book written by A. F. Ioffe, director of the Institute for Semiconductors of the U.S.S.R. Academy of Sciences. It is a general survey of the properties of solid electrolytes, metals and electronic semiconductors, followed by an outline of the quantum theory of semiconductors. Cleaver-Hume Press Ltd., 31 Wright's Lane, Kensington, London W8; about $8.75.

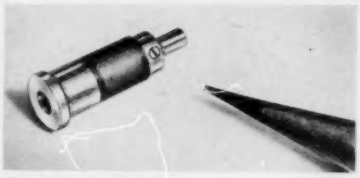
Soviet Instruments and Scientific Apparatus

Edited by C. W. Hanson, research director, ASLIB. This book provides descriptions with illustrations of around 190 instruments ranging from process control instruments to nucleonic apparatus; translated from recent Russian publications. Cleaver-Hume Press Ltd., 31 Wright's Lane, Kensington, London W8; about $5.75.

Advances in Vacuum Science and Technology

Proceedings of the First International Congress on Vacuum Techniques, Namur, Belgium; edited by Prof. E. Thomas. One hundred and fifty-six papers have been reproduced in two volumes. Vol. 1 is Fundamental Problems in Vacuum Techniques and Vol 2 is Vacuum Systems Applications in Various Sciences and Techniques. Pergamon Press, Inc., 122 East 55 Street, New York 22, N.Y.; Vol. 1, 508 pages; Vol. 2, 376 pages; $30.00 per set.

New components—cont.



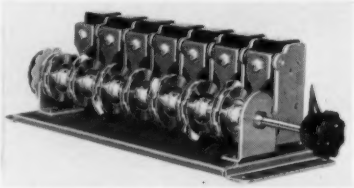
Crystal resistors 118

Crystal mounts and mixers can be checked and standardized independently of crystal impedance with these crystal type resistors. The resistors, on 1N21 or 1N23 crystal bodies, are supplied in any resistance value from 25 to 400 ohms with standard 2% or 5% tolerance. Power rating is 1 watt average at 100 C.

Filmohm Corp., New York, N.Y.

Adjustable selector switch 119

Industrial Timer Corp. series SS adjustable 12 position rotary selector switch had been designed for rapid program changes. Each load circuit is adjustable through 1 to 12 on-off positions. 1 to 20 load circuits are available as standard equipment with 10 amp contact rating for



each circuit. Circuit adjustment is quickly accomplished by inserting removable cam segments in one to twelve available locations.

A. C. Simmonds & Sons Ltd., Toronto.

Varactor diodes 120

Microwave Associates type MA-4297 silicon mesa varactor diodes with 120 Gc cutoff frequency are housed in hermetically sealed reversible-polarity cartridges with outline dimensions similar to MA-450 series varactor diodes. Shunt capacitance is of the order of 0.4 pf and approximate series lead inductance is 2 nh. Low capacitance MA-4297 varactors used in 5500 Mc nondegenerate parametric amplifier equipped receivers are reported to have achieved stable over-all receiver noise figures of 2.2 db for ± 10 Mc bandwidth. Stable over-all receiver noise figure of under 1.8 db is reported for 3000 Mc radar receivers using nondegenerate parametric amplifiers with ± 10 Mc bandwidth at the 3 db point. In both cases, single sideband values are cited and ferrite circulator insertion losses are included.

E. G. Lomas, Ottawa.

Controlled rectifier 121

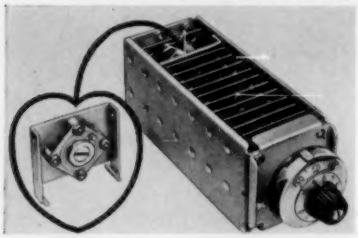
Miniature Thyrode silicon controlled rectifiers weighing as little as 1/10 oz. are capable of directly replacing mechanical relays where load currents of 1 ampere are required. Designated types

X1RC2 through X1RC20, these seven new units have peak reverse voltage ratings of 20, 30, 50, 70, 100 and 200 volts. The low operating current range of these thyratron-like devices enable them to perform efficient power switching on such applications as computer circuitry, temperature control, etc.

Douglas Randall (Canada) Ltd., Scarborough, Ont.

400-position rotary switches 122

Removable wafer rotary switches types RSG-40 and RSG-30 handle up to 400 positions single pole; type RSG-21 handles up to 100 positions. Types RSG-40 and RSG-30 are also available with 2 poles, 200 positions. Switching is transferred from 1 wafer to the next through

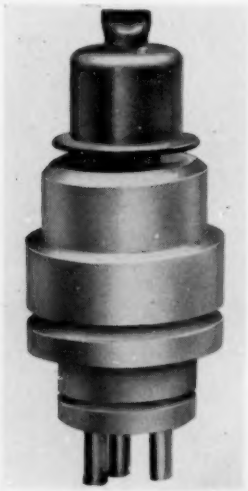


a Geneva gear control unit and its associated control wafer. Any wafer may be lifted out instantly without unsoldering or disassembling for fast, simple cleaning or replacement.

Chicago Dynamic Industries, Inc., Chicago.

3-pin transistor holder 123

Designed to eliminate holding failures of transistors undergoing shock, vibration and environmental tests, these transistor holders employ a spring loaded collet locking mechanism for positive, electrical conductivity regardless of the test their use in equipment designed for aging, reliability testing, and automatic checkout of transistors.



Jupiter Electronics, Inc., New York, N.Y.

(Continued on page 64)

CAMESA News

This bulletin has been prepared for CEE by the Director, the Electron Devices Division, and the Specifications Division, Canadian Military Electronics Standards Agency.

▸ To expedite the approval of Canadian military parts and materials by the U. S. Armed Forces and thereby remove technical barriers to the procurement of Canadian parts in the United States, CAMESA has established a separate section whose sole function will be to operate under the U. S. - Canada reciprocal approval agreement of July 1960. Canadian parts manufacturers are urged to apply to CAMESA for U. S. recognition of their qualifications under MIL electronic parts specifications and if such approvals do not exist, to apply to CAMESA for the establishment of qualification of Canadian-made parts. See article by A. P. Harris on page 32.

▸ Qualification of Canadian products by the U. S. Military Services this month includes the qualification of 42 types of wire and cable under three military specifications. These qualifications are granted by the U. S. Navy and the U. S. Air Force, to whom CAMESA applied on behalf of the manufacturer.

▸ The general specification for Semiconductor Devices MIL-S-19500B has now been issued together with the U. S. Preferred and Guidance List of Transistors MIL-STD-701A. MIL-S-19500B replaces MIL-T-19500 which only covered transistors.

▸ The Canadian Guidance List of Transistors has also been given wide distribution. Extra copies of this document are available upon request.

▸ A revised specification for Waveguide Assemblies, Flexible, Twistable and Nontwistable, MIL-W-287B, is in the final draft stage. In contrast to MIL-W-287A which only covers 'X' Band waveguide, the new specification will cover 10 sizes from 'L' Band through 'K' Band. Additional flexing requirements and a vibration test have also been added.

▸ A new specification for Adapters, Coaxial-to-Waveguide is in the final draft stage. This covers series N connectors, ⅝ coaxial and ⅞ coaxial line-to-waveguide adapters.

▸ Specification MIL-R-19365C cover-

ing adjustable wirewound power resistors has recently been issued. The resistance range is 1 to 15,000 ohms with a tolerance of ±5%, and current ratings from 11 to 210 watts.

▸ Specification JAN-R-29 has been superseded by specification MIL-R-29A, covering external fixed meter multiplier resistors. Deposited carbon elements in accordance with specifications MIL-R-10509, or wirewound elements may now be used.

▸ Specification MIL-F-18327A covering high-pass, low-pass, band-pass, band-suppression and dual-functioning filters has recently been issued. This specification is similar to specification MIL-T-27A covering transformers and inductors, and uses the same case sizes.

▸ Specification MIL-D-24A, covering dynamotors, has been superseded by specification MIL-D-24B. New requirements covering wax-coated capacitors, commutation, armature, corona discharge and sealevel life have been added.

▸ Specification MIL-A-27434A covering radio frequency coaxial connector adapters has recently been issued. The specification requirements are for weatherproof adapters having a nominal impedance of 50 ohms, designed for use between the various radio frequency connector series.

▸ Revised specification sheets MIL-C-17/16A, /17A, /40A and /45A covering radio frequency cables have recently been issued. Also, in connection with specification MIL-C-17C, Preferred Parts List PL-C-17C has been issued.

Defence contracts

Unclassified electronics contracts for $10,000 or more have been awarded to the following Canadian firms by the Department of Defense Production. A figure in parentheses indicates the number of contracts, the amount being the total value.

September 1-15, 1960

▸ Canadian Westinghouse Co. Ltd., Ottawa, repair and overhaul of radar equipment, $140,521.

▸ Computing Devices of Canada Ltd., Ottawa, technical representative, $13,051; equipment, $13,793.

▸ E.M.I.-Cossor Electronics Ltd., Dartmouth, N.S., development contract, $27,-960.

▸ Field Aviation Co. Ltd., Malton, Ont., telecommunication benches, $17,813.

▸ Marsland Precision Equipment Ltd., Waterloo, Ont., sonar equipment, $79,-230.

▸ Mel Sales Ltd., Toronto, radar test sets, $43,450.

▸ Silvercel of Canada Ltd., Toronto, batteries, $69,500.

September 16-30, 1960

▸ Alpha Aracon Radio Co. Ltd., Downsview, Ont., telephone equipment, $18,815.

▸ Canadian Aviation Electronics Ltd., Montreal, modification of operational flight and tactics trainers, $53,005.

▸ Canadian Aviation Electronics Ltd., Winnipeg, installation of telecommunications facilities, $12,952.

▸ Canadian General Electric Co. Ltd., Toronto, components for bombing computers, $609,000; components for missile launching computers, $137,000.

▸ Canadian Marconi Co., Toronto, tubes, $28,154.

▸ Canadian Westinghouse Co. Ltd., Ottawa, tubes, $162,998.

▸ Computing Devices of Canada Ltd., Ottawa, equipment, $44,162.

▸ Muirhead Instruments Ltd., Stratford, Ont., spares, $46,958.

▸ National Telecommunication Supply Ltd., Ottawa, installation of radio transmitters, $12,685.

▸ Northern Electric Co. Ltd., Belleville, Ont., radar equipment, $473,026; electronic equipment, $48,859.

▸ Northern Electric Co. Ltd., Ottawa, test equipment, $330,718.

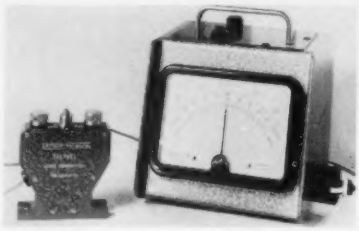
▸ Radionics Ltd., Montreal, equipment, $25,150.

New instruments—cont.

Automatic level 124

Compact Talyvel automatic level indicates deviations from level on a large centre-zero meter scale. Sensitivity can be varied from 1 to 20 seconds.

Engis Equipment Co., Chicago.



Magnetic tape tester 125

A tester introduced by Potter Instrument Co. detects magnetic tape defects as small as one bit length at speeds up to 150 ips and packing densities as high as 1500 bits per inch. Faults are indicated by a pilot lamp on each channel and the tape transport stops on the fault, which is accessible for inspection and repair. The tester, known as model 3320, is composed of a tape transport, manual pushbutton control unit, dual record-playback head, record-playback amplifiers, logic chassis with fault detector plug-in cards and space for up to 16 channels. Two combinations of tape speed and packing density can be selected.

Instronics Ltd., Stittsville, Ont.

Portable sound level meter 126

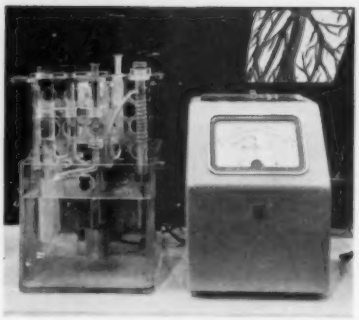
Completely transistorized and battery-operated, the new Miniphon sound level meters weigh only 15 ounces and measure 5 x 3½ x 1½ inches. Model B

has ranges from 40 to 125 acoustic db, contains standard weighting networks and can be used as a vibration indicator. Model A has a single range of 70 to 95 db and is designed for such applications as traffic noise studies.

R-O-R Associates Ltd., Don Mills, Ont.

Direct reading blood pH meter 127

Electronic Instruments, Ltd. direct reading meter type 48A has been designed solely for the measurement of blood pH, or its acidity and alkalinity limits. It utilizes a Vibron component which is a dynamic capacitor modulator used in measuring minute voltage changes. Blood pH changes usually are of the



order of ±0.005 pH within the range of 7.2 to 7.6 pH. Each division of the 6.6 to 8.0 pH scale represents only 0.01 pH, thus readings are possible to ±0.005 pH. Zero stability of the type 48A is better than ±0.005 pH in twelve hours. The meter has provision for checking electrodes in a buffer solution of 9.1 pH, so that any change in linearity in the glass electrodes can be observed and corrected.

Measurement Engineering Ltd., Arnprior, Ont.

Direct reading vacuum tube voltmeter 128

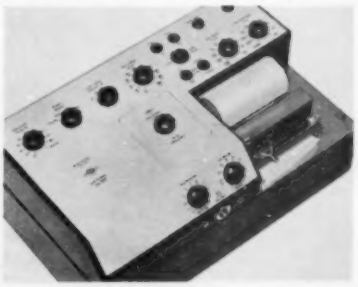
Ballantine Laboratories model 300G direct reading vtvm offers 1% accuracy at all points on the meter scale over the frequency range of 20 cps to 20,000 cps, and the voltage range of 1 millivolt to 250 volts. Model 300G comprises a high impedance attenuator followed by a feedback stabilized amplifier which feeds an average responding rectifier-meter circuit.

Complete voltage range is 1 millivolt to 1,000 volts rms in 6 decade ranges of 0.01, 0.1, 1, 10, 100 and 1,000. Frequency range is 10 to 250,00 cps.

Bayly Engineering Ltd., Ajax, Ont.

Level recorder 129

Bruel & Kjaer level recorder type 2305 has been designed to enable accurate recording of signal levels in the frequency range 10 cps to 200,000 cps. Typical



applications are the recording of frequency response characteristics, reverberation decay curves, noise and vibration levels and spectrograms. Recordings can be made by means of ink either on lined or frequency calibrated paper, or by means of sapphire stylus writing on wax coated paper.

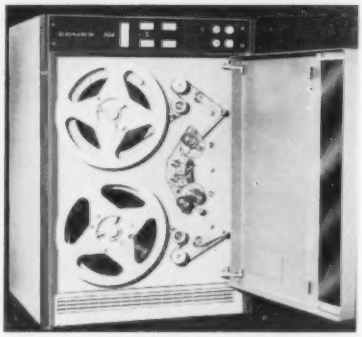
R-O-R Associates Ltd., Don Mills, Ont.

(Continued on page 66)

New equipment—cont.

Data transmission equipment 130

Comex communications equipment designed by the Crosley Division of Avco Corp., can be used to send data over standard telephone circuits. Each Comex unit consists of a two-speed magnetic tape recorder capable of recording the output of a standard teletypewriter on magnetic tape at normal speeds of 60-100 words per minute. The tape is then run at ten times the slow speed to transmit the information over a standard telephone (voice channel) circuit. At the receiving end, the message is recorded at high speed, then fed into a teletypewriter



at slow speed for print-out. Comex has been developed to be compatible with American Telephone and Telegraph Company's service for transmission of teletypewriter messages and data over long distance telephone lines. It can be used with presently installed teletypewriters and is designed for connection through the Bell Dataphone unit to insure adaptability to any installation calling for wire service.

Moffats Ltd., Weston, Ont.

Compressor-limiter amplifier 131

Westrex amplifier model RA-1593-A and control unit model RA-1594-A form a compressor-limiter amplifier for general audio-frequency use. The system has been designed for use where the amplitude of the original signal is greater than the useful range of the recording or broadcasting equipment.

Tele-Radio Systems Ltd., Toronto.

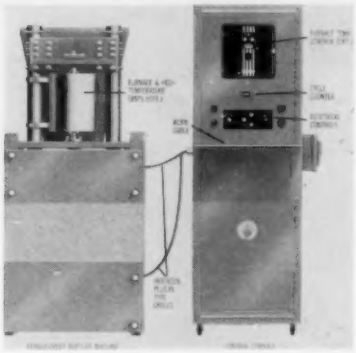
Audio tape recorder 132

Specialist 900 tape recorder is a 4-track, stereophonic playback type with an "add-a-track" feature. It will play all stacked or inline tapes, staggered tapes, and the new 4 track tapes. The add-a-track feature makes it possible to record a master track, they play back the master through earphones while simultaneously recording on an additional track. The additional track then contains the composite recording from the master plus added sound, leaving the master track unchanged.

Bell & Howell Canada Ltd., Toronto.

Fatigue machine 133

Budd combination fatigue testing machine model LAZ-1 provides for static or dynamic testing on a selective basis;



creep or fatigue work may be accomplished with either of the machine's two sections: the static unit (LAZ-1S), the dynamic unit (LAZ-1D), or both. The units may be removed and assembled in combination for direct use on structures too large or complex to be tested in the machine itself.

Tatnall Measuring & Nuclear Systems Ltd., Toronto.

Variable frequency power source 134

Krohn-Hite model LDS-1500 50-watt variable frequency power source enables users of ac voltmeters, ac ammeters and digital meters to calibrate their own instruments. Amplitude stability is better than 0.01%; harmonic distortion is only 0.1%. It is continuously variable up to 1500 volts, up to 12 amps, at any frequency between 20 and 20,000 cps.

MEL Sales Ltd., Toronto.

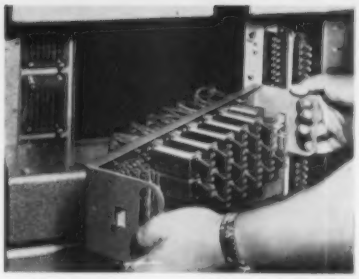
Circuit board drilling machine 135

Nawide model 151 printed circuit board drilling machine can drill more than 64,000 burr-free holes per 8-hour shift. Accuracy of hole spacing permits 0.004 inch wall thickness. Circuit boards can be drilled individually or simultaneously in stacks up to 5 boards. Drill capacity is 0.020 in. x 0.250 in. diameter. Spindle travel is 1¼ in. Throat depth is 10 in.; drill thrust is 0 to 400 lb.

Hope Machinery Co. Ltd., Toronto.

Communications switchboard 136

An automatic internal communications switchboard, called the Telematic switchboard, can be expanded by plugging in additional assemblies as needed. By means of plug-in relay sets and plug-in connecting cables, it can be assembled to provide any number of stations up to 240 and as many as 32 links. Also, the number of stations in any installation can be increased by about 20 to 25% by adding selective ring common talk stations. The system comprises a basic 60 line 8



link switchboard and power supply, extension frames, and group selector frames.

Dictograph Products Inc., Jamaica, N.Y.

Data transmission equipment 137

Digitronics Dial-o-verter system was created to function with the Bell Telephone System Data-Phone 200. It makes possible the transmission and receipt of volumes of data, to and from many remote locations at a speed of 150 characters per second over regular telephone lines. It can read or write via punched paper tape, punched cards or magnetic tape, and can transmit in one medium and have it received in another. The system refuses to send data unless the transmission line is acceptable, and will permit unattended operation.

Digitronics Corp., Albertson, Long Island, N.Y.

Association formed to stimulate nuclear development in Canada

An organization has been formed to stimulate Canadian development of nuclear energy for peaceful purposes. Under the name of the Canadian Nuclear Association it will operate as a central agency for government bodies, industry, utilities, educational institutions and other authoritative groups interested in nuclear development.

McRae

Macaulay

President of the new association is I. F. McRae, chairman of the board, Canadian General Electric Co. Ltd. Vice-president is Honourable R. W. Macaulay, Ontario Minister of Energy Resources.

Services which the association will offer include studies of technical problems, professional and technical manpower requirements, legislation and insurance problems, public and industrial education, publications on various aspects of development and opportunities at home and abroad.

A committee headed by Dr. J. W. T. Spinks, president of the University of Saskatchewan, has started a survey of all types of nuclear education now offered in Canada. It will determine the number of students receiving such education and chart their availability to take up careers in the nuclear field, study university research projects and offer guidance, and investigate the effectiveness of special study courses to broaden nuclear education.

Persons interested in membership or other news should contact the association at Box 475, Adelaide Street Post Office, Toronto.

Hi fi association elects officers

At the fourth annual meeting of the Dominion High Fidelity Association, held in conjunction with the High Fidelity Exposition in Montreal last month, the following officers were elected: John R. Tilton of John R. Tilton Ltd., president; Ian J. Main of Dominion Electrohome Industries Ltd., vice-president; E. H. Kinnear of Ampex of Canada Ltd., secretary-treasurer.

In addition, the following directors were elected: J. B. Smyth of Smyth Electronic Components Ltd.; J. R. Bass of Atlas Radio Corp. Ltd.; John D. Hackbusch of Hackbusch Electronics Ltd. I. Main was appointed chairman of public relations and publicity, and W. Farrow was appointed chairman of the qualifications committee. John T. Rochford was reappointed executive secretary and show manager.

Industrial conference

A province-wide industrial development conference with the theme "Increased employment through accelerated industrial development," will be held at the Royal York Hotel, Toronto, November 24-25. It is being sponsored by the Ontario Government's Trade and Industry Branch under the direction of F. J. Lyle. More than 1,000 delegates from executive ranks of business, industry, government and municipal life are expected to attend.

International trade fair

More than 20 nations are expected to be represented by their governments at the British Columbia International Trade Fair, May 3-13, 1961, at Vancouver, B.C. In addition, there will be individual commercial exhibitors from many countries. Full information about exhibition space can be obtained from The General Manager, 1961 British Columbia International Trade Fair, Exhibition Park, Vancouver, B.C.

Pacific electronic trade show

A new trade show has been established devoted to the western marketing needs of the electronic components industry in the United States and Canada. The Pacific Electronic Trade Show is to be sponsored and produced annually by the western distributor segment of the industry. Its location will rotate among major cities throughout the west. First show will be held in Los Angeles, February 26-March 1, 1961. Further information may be obtained from Pacific Electronic Trade Show, 2216 South Hill Street, Los Angeles, Calif.

IRE Section meetings

Kitchener-Waterloo: Nov. 21; "Soviet research in circuit theory and automatic control," by Dr. M. E. Van Valkenburg, Univ. of Illinois; Univ. of Waterloo, 8.15 p.m.

Toronto: Nov. 14; "Acoustics and the ear," by W. E. Hodges, electro-acoustical consultant; Hart House, 7 p.m.

Dec. 5; Tour of Trans-Canada Telemeter, Toronto. Tickets must be obtained for this tour; contact Miss Kent, ME 3-1482.

COMING EVENTS

November

8-9 Symposium on Space Instrumentation, IRE, Washington, D.C.

9-11 Power Industry Computer Application Conference, Chase Hotel, St. Louis, Mo.

21-25 2nd Industrial Photographic and Television Exhibition and Conference, Royal Albert Hall, London, England.

December

11-14 Eastern Joint Computer Conference, IRE, AIEE, ACM, New York.

12-15 Atomfair-West, and American Nuclear Society 1960 Winter Meeting, San Francisco.

14-16 Atomic Industrial Forum 1960 Annual Conference, San Francisco.

January 1961

17-19 ISA Winter Instrument-Automation Conference & Exhibit, St. Louis, Mo.

February

1-3 1961 Winter Convention on Military Electronics (IRE). Biltmore Hotel, Los Angeles.

Electronics in industry

What's ahead for electronics in Canadian industry? . . . What are the problems in selling new techniques? . . . What are the economic factors faced by the user?

These and many more pertinent questions will be dealt with in the December issue of CEE. Emphasis will be on "philosophy", rather than examples, so that readers will be able to apply the information to their own problems.

Free service for our readers

Keep your reference shelf up to date this easy way. All advertisements, new products and literature in this issue have a key number. For more information

- **Circle the key number on one of these cards**
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Advertisers' Index

This precision DC VTVM is also a wide range, precision ohmmeter and ammeter!

1% accuracy 100 μv to 1,000 volts!

Also 2% accuracy, 1 μa to 1 amp full scale.

Measures 0.02 ohms to 5,000 megohms.

No zero adjustment. 1 minute warm-up.

Floating chassis. $1,000 worth of convenience for $350!

Haven't you wished for one compact, simple instrument that would make *precision* dc voltage, dc current and resistance measurements over a wide range?

The new hp 412A is it! In its VTVM circuit, the 412A uses an exclusive hp photo-chopper instead of old-style mechanical vibrators—no drift, no 60 cps pickup. Input is floating, with resistance increasing from 10 megohms on the 1 mv range to 200 megohms on ranges above 100 mv. Current and voltage ranges have a 10 db sequence for maximum readability and overlap. The ohmmeter is a modified Kelvin bridge eliminating lead resistance error; you measure resistance accurately on hook-up wire sections as short as 6″.

Model 412A also includes a 1 v or 1 ma recorder output, and 3 separate probes. Call your hp rep today for a demonstration on your bench. Price, $350.

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hp 400L LOGARITHMIC VOLTMETER—$325

New hp voltmeter covers 10 cps to 4 MC; accuracy high as ±2% of reading or 1% of full scale. Voltage range 0.3 mv to 300 v, 12 ranges, 1-3-10 sequence. Max. full scale sensitivity 1 mv. Large 5″ true log voltage scale, linear 12 db scale, generous overlap. High stability, high input impedance. Also useful as amplifier for small signals, or to monitor waveforms.

hp 400H PRECISION VOLTMETER—$325

Extreme accuracy as high as ±1% to 500 KC, ±2% to 1 MC, ±5% full range. Frequency coverage 10 cps to 4 MC. Large 5″ meter with precision mirror scale. Voltage range 0.1 mv to 300 v; max. full scale sensitivity 1 mv. High 10 megohm input impedance minimizes circuit disturbances. Amplifier with 56 db feedback insures lasting stability. Reads direct in db or volts.

hp 400D WIDE RANGE VOLTMETER—$225

Highest quality, extremely versatile. Covers 10 cps to 4 MC. Highly sensitive, accurate to within ±2% to 1 MC. Measures 0.1 mv to 300 v; max. full scale sensitivity 1 mv. Reads direct in dbm. High 10 megohm input impedance virtually eliminates circuit loading. 56 db amplifier feedback insures high stability and freedom from change due to external conditions.

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hp complete precision voltage measuring equipment

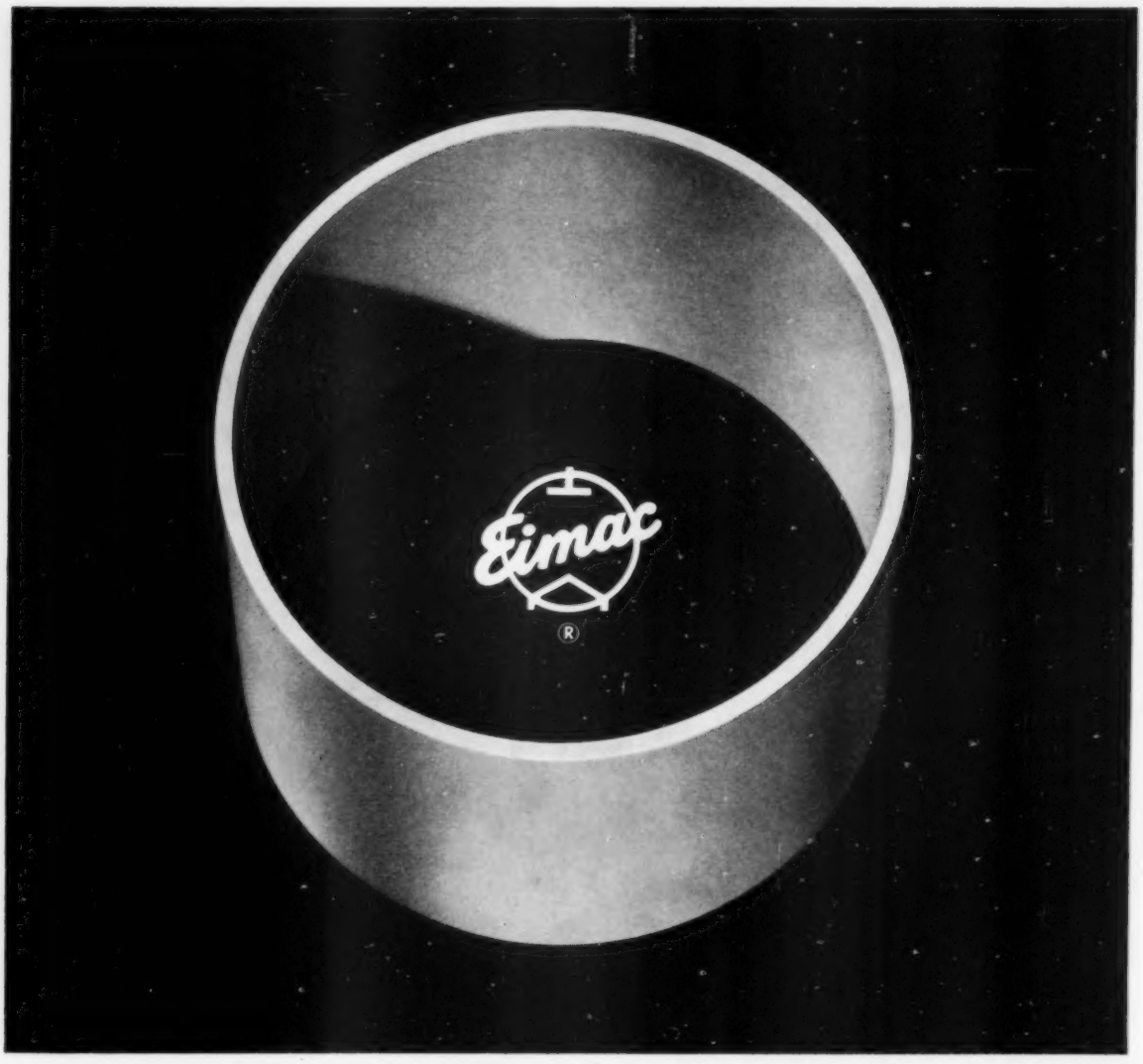
FROM EIMAC:

Breakthrough in tube technology opens up new range of reliability

You are looking at a major advance in tube design. This ceramic envelope is made with *beryllium oxide* —an amazing insulating material now introduced by Eimac for electron tubes. It offers thermal conductivity *ten times* greater than any other material in use today. It provides low losses, high breakdown strength and a comparatively low dielectric constant for improved bandwidth in critical applications such as output windows.

With the introduction of beryllium oxide, Eimac breaks through the problem of dissipating ever larger amounts of heat in dielectrics. And opens a new chapter in power-output capabilities of high power microwave and certain negative grid tubes. The result: a whole new spectrum of tube reliability and performance. Beryllium oxide is now being used in several Eimac production tube types generating ten kilowatts and above.

This significant advance in the state of the art of manufacturing electron tubes has been pioneered by an Eimac sponsored research program. Eimac sponsored research has also resulted in the recent introduction of the first practical quartz-to-metal seal. Eitel-McCullough, Inc., San Carlos, California.



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